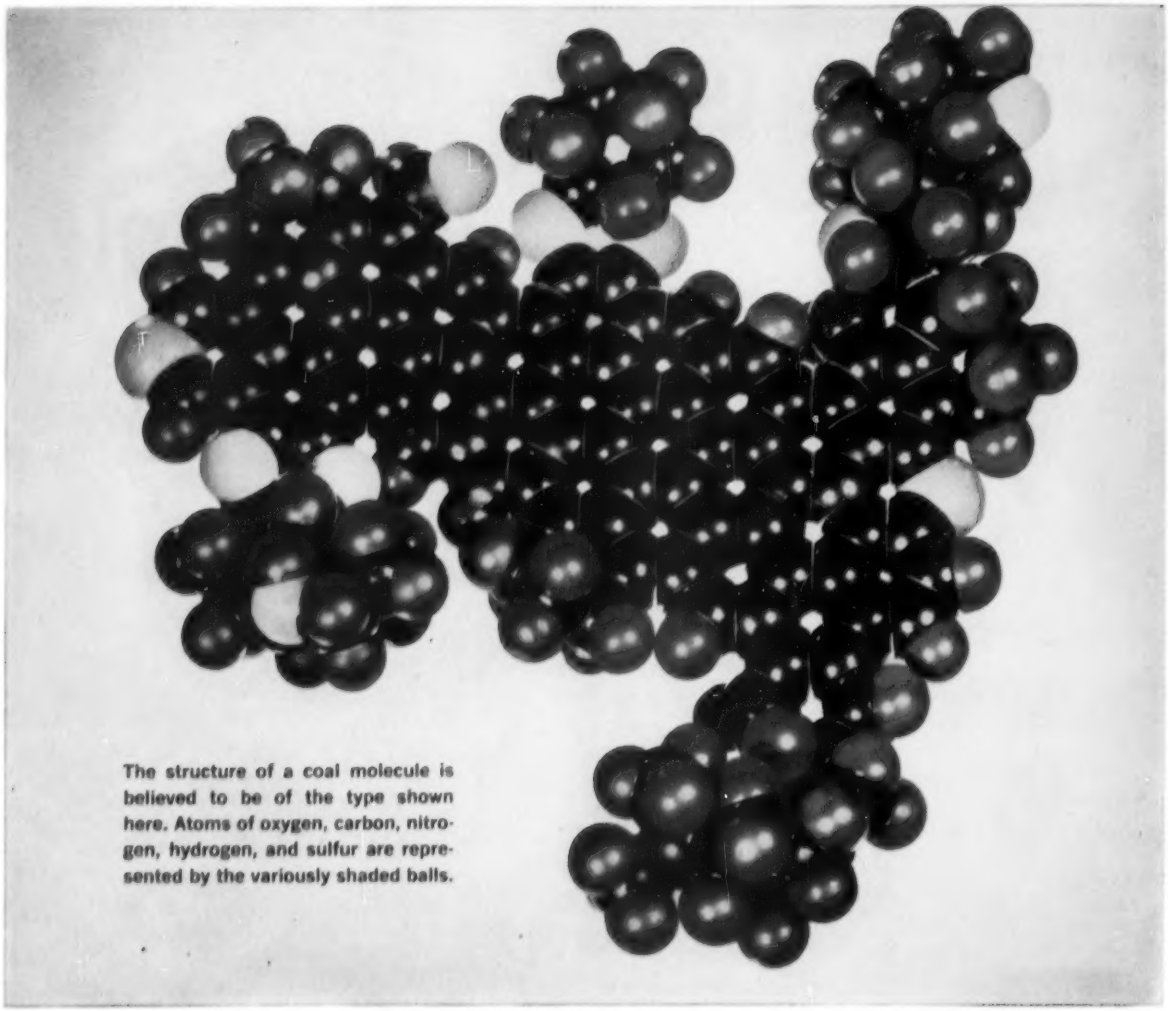
the Cornell engineer

The Liberal-Technical Challenge For Cornell Education

MARCH, 1958
VOL. 23, NO. 6
25 CENTS

COLLEGE OF ENGINEERING CORNELL UNIVERSITY



The structure of a coal molecule is believed to be of the type shown here. Atoms of oxygen, carbon, nitrogen, hydrogen, and sulfur are represented by the variously shaded balls.

Here's the alma mater of 200,000 successful grads

More than 1900 chemicals have been found in coal, and over 200,000 different products are made from them—products like plastics, synthetic rubber, synthetic fibers, and resins. There's still more to come. Only a fraction of the 1900 chemicals in coal are currently used commercially.

Today, United States Steel and other producers of coal chemicals continue to study coal, its structure, and its future potential as a source of basic chemicals.

Why, you may ask, are we so interested in chemicals when our principal business is steel? The reason is that it's just good business. In producing coke for our steel-making operations, we also produce chemicals. Thus we are always interested in anything, and *anybody*, that will help to advance the technology of these related products, improve their quality, and in general reduce the over-all cost of manufacture and provide better products and better service for our customers.

It's a big job and we need a lot of good people to do it—physicists, chemists, geologists, all kinds of engineers—people with *your* training. If you want to explore the earth's surface for ore, delve into the commercial use of coal chemicals, help rocket designers solve new problems with new steels, there might well be a place for you at United States Steel. Write for our booklet, "Paths of Opportunity"—United States Steel, Personnel Division, Room 2801, 525 William Penn Place, Pittsburgh 30, Pa.

USS **United States Steel**

To **engineering undergraduates** in a whirl about the future...

AT DOUGLAS, YOUR ASSIGNMENTS HAVE THE SCOPE THAT LETS YOU PROGRESS AT YOUR OWN PACE!

Going around in circles? Chances are you're wondering what your future holds. At Douglas, long-range projects of tremendous scope assure a constant variety of assignments . . . and the opportunity to expand your responsibilities. Douglas is headed by engineers who believe that promotion must come from within. They'll stimulate you to build a rewarding future in your field.

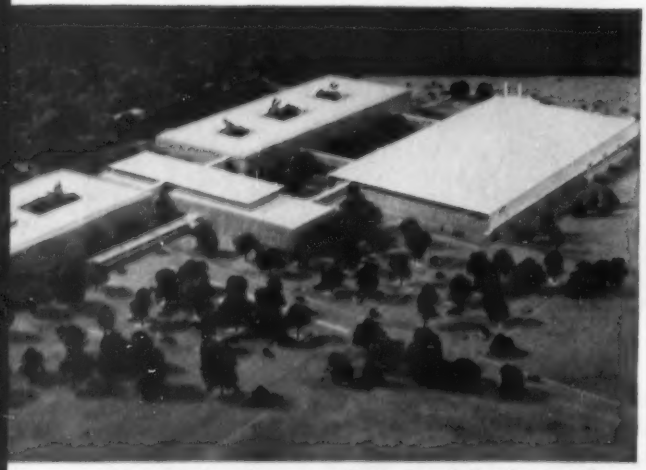
For important career opportunities, write:

C. C. LaVENE
DOUGLAS AIRCRAFT COMPANY, BOX 6102-R
SANTA MONICA, CALIFORNIA

Go further with **DOUGLAS**

FIRST IN AVIATION

Dennis W. Holdsworth



Pictured above is our new Research and Development Center now under construction in Wilmington, Massachusetts. Scheduled for completion this year, the ultramodern laboratory will house the scientific and technical staff of the Avco Research and Advanced Development Division.

Avco's new research division now offers unusual and exciting career opportunities for exceptionally qualified and forward-looking scientists and engineers.

Write to Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development Division, 20 South Union Street, Lawrence, Massachusetts.

IDEALS AND PRACTICALITY

"Science and Philosophy mutually criticize each other and provide imaginative material for each other."... Alfred North Whitehead.

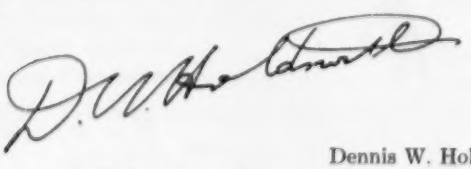
In the increasing preoccupation of science with material things and progress, the truth of this statement by one of our greatest philosophers is often overlooked and forgotten. The scientific philosopher is a rare being and is becoming rarer still, nor can he be adequately replaced by the group technique or the 'brainstorm' session.

It should be one of the noblest aspirations of all our sciences to provide for the true contemplation of the inner meaning of facts and to stimulate that interplay of mind on mind by which alone we may progress.

In all these things, however, we cannot forget the problems peculiar to research and development in private industry. The obligation to work to otherwise-determined time-scales poses a nice problem in balancing ideals against the practicalities of everyday life.

It is in this field that the test of management comes. Its success at meeting such continuously conflicting requirements determines the character and ultimate success of the organization.

With such thoughts as these in mind, we here at Research and Advanced Development Division of AVCO are seeking unique people. We wish to foster the creative minds and fundamental thinkers, while preserving an atmosphere of self-discipline, free from a rigid hierarchy of command and organization.



Dennis W. Holdsworth,
Manager, Computer and Electronic Systems Department

AVCO
Research & Advanced Development

All this good news from one company in one year

inghouse Electric
ales Should Top
of '57, Price Says

This Year Put 30% Above
Outlook Called Good
Wide Industry

Motors For Steel Mills

Westinghouse Sells Eight-Million-Dollar Order To Austria

East Pittsburgh, Nuttall And
Plants To Join In Making Ec

Jet Contract Goes To Westinghouse

$17 Million Navy Contract

Westinghouse To Expand Atomic Fuel Manufacturing Operations At Cheswick

— Westinghouse Electric Corp
is expanding its facilities here
components and complete core
e company's atomic fuel depart-
cinctury, high-bay extension

ays," Mr. Fox said, "and this
growth of our operations requ
with continued interest and in
effort o

Westinghouse Constructing
Three 19,200-kw Generato
Construction of these 19,200

Three Part Rail Car Designed By Westinghouse

A railroad car to three parts
—one part being the actual
and the car is carrying—has
been designed by Westing-
house Electric Corporation for

Westinghouse President Sees 1958 Net Hitting New Post-War Record

By a WALL STREET JOURNAL Staff Reporter

BOSTON, (1/13)—Westinghouse Electric Corp.
ething more than a
after profits in 1958.
I and chairman, told

Backlog Mounts At Westingh

PITTSBURGH—The
ng of Westinghouse Elec
emains at a high leve
he fact that record sa
completed and billed d

Power Firm Orders WE Generators

Westinghouse Develops Generating System For Supersonic Bomber

Assembly Line Is Set For A-Power Equipme

MAIN,

Jet Contract Goes
To Westinghouse

W
Se

Generator Contract
South's Biggest

Work For East Pittsburgh

$9,700,000 Order Let For Turbines

Westinghouse Equipment To Power
Vess
Plones

Pron
four of i
will be
$9,700,00

These
energy p
ation

Westinghouse Sales Up 22% To New High

Nine-Month
Profit Totals
$49,102,000

From First Commercial Plant

Atomic Power Lights City

SHIPPINGPORT SWINGS INTO OPERATION

the stories, pictures on Page 7.

Westinghouse Gets Contract For Hospital's Power Work

Westinghouse Bui Tallest Heat Treat

The nation's tallest heat
than a 10-story building, is n
Aluminum plant in Torrance, C

One hundred an dten foo
diameter, the vertical electric
and constructed by the indust
Westinghouse Electric Corpor
cooled aluminum alloy object
controlled temperatures to ma
strength of precision aluminum
tion, and other uses.

Aluminum pieces up to 8
ed in the furnace and heat
up through 900 degrees Fahre
heating cycle, a door at bottom
ed and the aluminum parts ar
ground quenching tank 110 f
diameter. After a finishing pa
the aluminum is ready for ship

ns $4 Million
Contract;
Plant to Aid

Westinghouse Develops Ultra-Pure Silicon

WORLD'S PUREST SILICON — one of the
materials used in "solid state" electronic dev
has been made available to American manufactu
by Westinghouse Electric Corporation.

Westinghouse plans to license other companie
manufacture of the new u
ns and developments lea
riginated with a compan
was supplemented by ce
made by Westinghouse.

of the United States sil
nto rectifiers. Transistors
en predominantly made f
it has been known for s
are silicon would be
d transistors due to Ne
erature limits and

Aut

estinghouse Builds Two Most werful Hoisting Units in Nation

W YORK, N. Y. — Equipment to
and control the two most power
mine hoists ever to be installed
the country has been ordered from
Westinghouse Electric Corporation,
Kerah, vice president northeast
region, announced.

e hoists to go in the 4,720-foot
Ryan shaft of the Anaconda
pany in Butte, Mont., will be

the hundreds of miles of mine work
ings honeycombed beneath the Butte
Hill.

The order totals over $1,000,000
and includes motors, motor generator
sets, and speed control equipment to
drive each hoist with a payload of
36,000 pounds up the vertical shaft
at a rate of better than 30 miles
hour. The hoists will operate
four levels, the shallowest 1,636
and the deepest 4,720 feet below
collar of the shaft. Total cycle
including loading of the skip
for each capacity load from the
est level will be less than two min

Westinghouse Renews Employe Stock Purchasing Plan on June 1

PITTSBURGH Pa., May 13—
Westinghouse Electric Corp. will
offer 400,000 shares of common
stock to employes under a re-
establishment of the former em-
ployee stock purchase plan begin-
ning June 1. It was announced
today by Gwilym A. Price, chair-

ployes. He said that about 22,500
employes now own company
stock.

"The proposed plan will be the
same as the 1950 employe stock
plan and is, in effect, a resump-
tion of the previous program," he
said. "The program will begin

'Sherwood' Joined By Westinghouse

Thermonuclear Work
Un

Westinghouse Inventors Set New Record

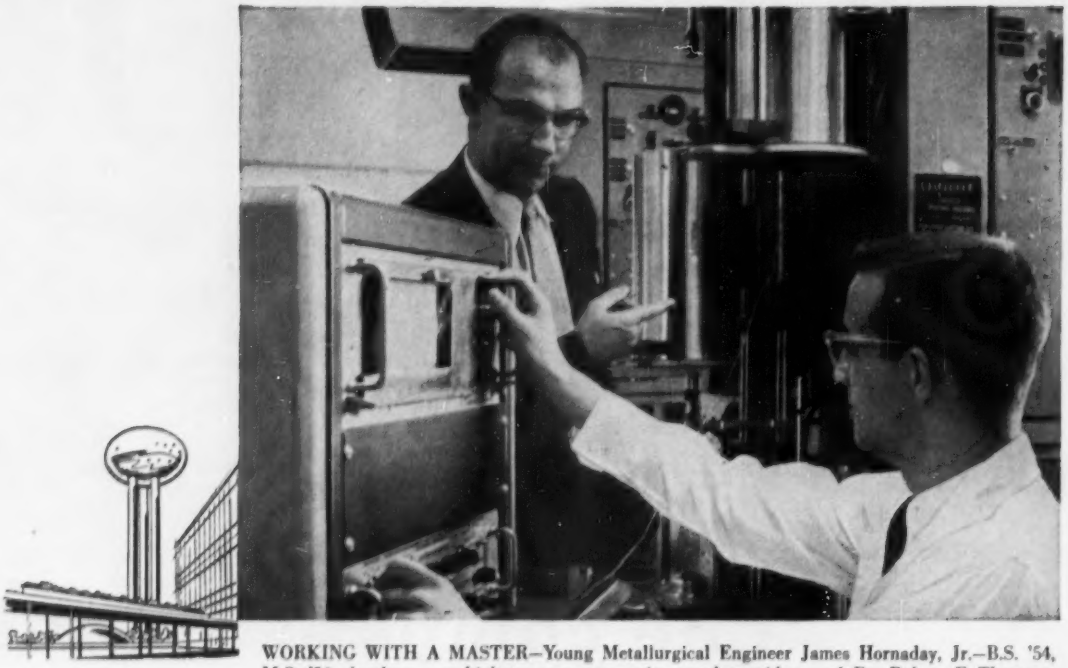
Drilling Tenders to be Built by We

Westinghouse... first with the future

participate in the program are
those in the lamp division plants
in Bloomfield, Belleville and
Trenton, N. J.; Fairmount, W. Va.;
Richmond and Greensboro, Ky.

he said, "we have received inquiries about the pos-
sibility of resuming the sale of
stock to employes. This sustained
interest in owning the company's

ire silicon have pr
amps and a gain of



WORKING WITH A MASTER—Young Metallurgical Engineer James Hornaday, Jr.—B.S. '54, M.S. '56—develops new high-temperature coatings under guidance of Dr. Robert F. Thomson. Head of Metallurgical Engineering Department of GM's Research Staff, Dr. Thomson is recognized as one of the nation's leading metallurgists—has pioneered many advancements in his field.

Because *engineering* is a *profession* at GM—your professional stature grows year by year

HERE's something of serious importance to you as a young graduate engineer:

Are you taking just a job—or are you going out to really *practice* the respected profession for which you have been so fully trained?

Here at General Motors we long ago recognized that engineering is a profession—and began treating our engineers who work on our hundreds of products as professional men.

For example our engineers are used on assignments that give them an opportunity to use their training and education as they were meant to be used. To let them practice engineering.

Or take the fact that GM encourages its engineers to gain professional recognition by presenting technical papers to engineering societies.

Take, too, the encouragement our engineers receive in working for advanced degrees, in doing original research. The fact that over 179 of our engineers and scientists received over 164 patents for such work in a recent four-month period is one indication of the opportunity for creative work here at GM.

And these are but a few examples of the fact that engineering is a profession at General Motors.

Why do we place engineering in this special category? Because we know that from the work of our engineers at our 35 divisions and 126 plants in 71 cities and 19 states—and at our huge Technical Center near Detroit—will come the products that will keep General Motors on its progressive path.

Naturally, you get more than professional recognition. Your salary reflects your ability and progress.

And, of course, there is opportunity without limit. For 14 of the 33 GM Vice-Presidents are engineers, as are 23 of the 42 Division General Managers.

Today we are looking for young men who may fill tomorrow's GM executive positions. Should you wish to join us and practice your profession as you build your career, let us hear from you. It could be the most important letter of your life.

• • •

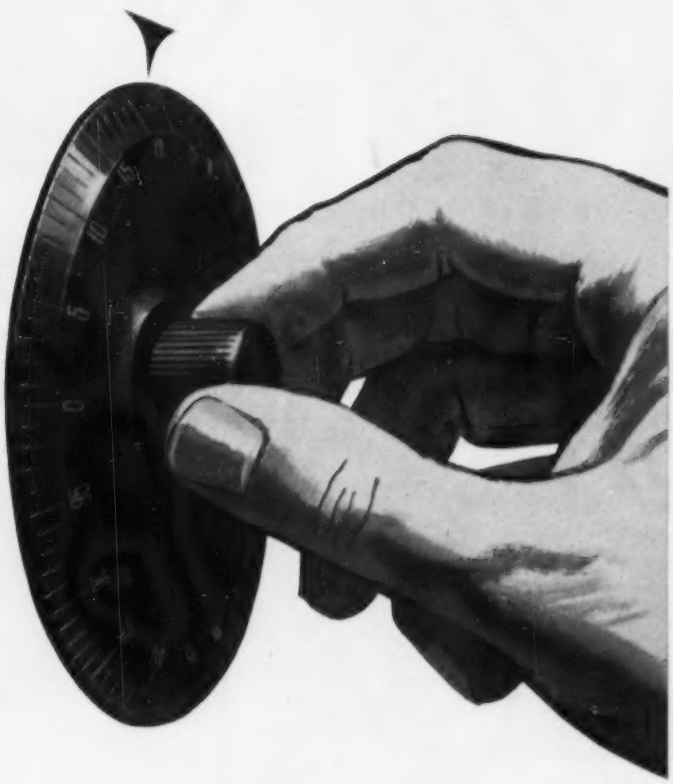
GM positions now available in these fields:

MECHANICAL ENGINEERING • ELECTRICAL ENGINEERING
INDUSTRIAL ENGINEERING • METALLURGICAL ENGINEERING
AERONAUTICAL ENGINEERING • CERAMIC ENGINEERING
MATHEMATICS • INDUSTRIAL DESIGN
PHYSICS • CHEMISTRY

GENERAL MOTORS CORPORATION

Personnel Staff, Detroit 2, Michigan

A good combination is hard to beat



So is the future of the man who charts his course wisely. Choose a company that offers you the combination of opportunities so necessary to your professional growth. At Bendix you will find such a combination—a tradition of achievement and continued growth spanning more than three decades, a forward-thinking management team that is truly "engineering minded", unexcelled facilities, a diversity of products serving every basic industry. Engineering is a key factor in the company's operations. Bendix has a continuous need for the best engineering talent available.

Bendix has long adhered to a policy of advancement from within. Of the nine new divisions added during the past seven years, all have been staffed from within. With a diversity of products and engineering opportunities at hand, you may assure your future at one of twenty-four Bendix divisions located throughout the country, working in the field of your choice.

Bendix has need of men of talent in such fields as Electronics, Electromechanics, Ultrasonics, Systems, Computers, Automation and Controls, Radar, Nucleonics, Combustion, Air Navigation, Hydraulics, Instrumentation, Propulsion, Metallurgy, Communications, Carburetion, Solid State Physics, Aerophysics and Structures.

Check with the placement director for information regarding Bendix opportunities and interview dates. Or write to Dr. Gerald A. Rosselot, Director of University and Scientific Relations, Bendix Aviation Corporation, 1107 Fisher Building, Detroit 2, Michigan.

A thousand products Bendix AVIATION CORPORATION Fisher Bldg., Detroit 2, Mich. *a million ideas*

Left to right: Lou Bernardi, Notre Dame, '54; Norman Lorenson, Mich. St., '55; Ernest Schurmann, M.I.T., '53; Dick Swenson, Purdue, '50.

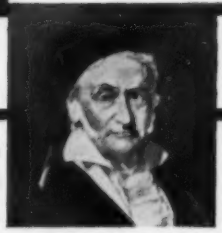
Go with us... and you'll Grow with us!

CONVAIR
FORT WORTH

CONVAIR IS A DIVISION OF GENERAL DYNAMICS CORPORATION

EUCLID

LOBACHEVSKY



GAUSS

PHOTOS BETTMANN ARCHIVE

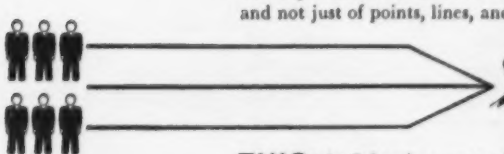
ENGINEERS and SCIENTISTS

when parallels meet

...as in advancement opportunities at Sylvania

It remained for Nicholas Lobachevsky to solve a riddle that bothered mathematicians for the better part of twenty-two centuries.* He was able to construct a rational geometry by denying Euclid's fifth postulate — by maintaining that parallels *do* meet.

Here at Sylvania Electric we have a noneuclidean geometry of our own, in which parallels also meet. It's a geometry of professional development, though, and not just of points, lines, and planes.



WHAT DO WE MEAN?

THIS: At Sylvania a man advances by one of two parallel paths.

If his interests and talents lie in the areas of engineering and scientific specialization, he advances as a *specialist.*

If his forte is in the areas of organization and administration, he advances through *management.*

These parallel paths meet in a common point: At Sylvania a man knows that he is given the fullest opportunity to develop and exercise his talents. He knows that a man goes as far and as fast as he is able in the path of his choice. Whether he chooses management or specialization, he finds *equal* rewards and compensation.

Graduates and men with advanced degrees in science and engineering will discover Research, Development, Manufacturing and Marketing careers at Sylvania — in specialization or management — in:

LIGHTING, RADIO, TV, HI-FI, ELECTRONICS, SEMICONDUCTORS, PHOTOGRAPHY, COMMUNICATIONS & NAVIGATION SYSTEMS, AIRBORNE DEFENSE, RADAR, ECM, MISSILES, COMPUTERS, CHEMICALS, PHOSPHORS, PLASTICS, METALS & WIRE.

Contact your college placement officer for an interview, or write us and ask for a copy of "Today & Tomorrow with Sylvania".

*WE MEAN NO DISCREDIT TO BOLYAI OR GAUSS. LOBACHEVSKY MUST TAKE CHRONOLOGICAL PRIORITY, HOWEVER.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.

LIGHTING • TELEVISION-RADIO • ELECTRONICS • PHOTOGRAPHY • ATOMIC ENERGY • CHEMISTRY-METALLURGY

Richard G. Brandenburg	ME '58	Editor-in-Chief
John M. Walsh III	ChemE '59	Managing Editor
David N. Koppes	CE '59	Business Manager

PUBLICATION BOARD

Alan S. Rosenthal	EE '60	Assistant Editor
Harry A. Fertik	ME '59	Associate Editor
Jeffrey I. Frey	EE '60	Illustrations Editor
Robert M. Bryant	ME '59	Treasurer
Sidney Turkish	EE '59	Circulation Manager
Chester R. Fox	ChemE '60	Advertising Manager
David A. Hodges	EE '60	Publicity Manager
Barbara Jo Merkens	Arts '58	Office Manager
Frank F. Walsh	ChemE '59	Assistant Managing Editor

Editorial Board

D. Lamensdorf	EE '60
R. Lamm	ChemE '61
P. Jedel	EE '61
W. Easton	EP '60
L. Wheeler	ChemE '62

Business Board

W. Balet	EE '59
R. Loane	EE '60
S. Saperstone	EE '61
E. Hoffman	ChemE '61
R. Tesarik	EE '60
L. Rosenthal	EE '61
L. Goettler	ChemE '62
F. Winslow	EE '62
J. Pease	CE '62
T. Spar	CE '62
H. Marantz	EE '62
S. Hansen	CE '62

Illustrations Board

K. Workman	EP '60
E. Gregersen	ME '60
R. Reif	Arch '61
R. Franson	EP '62
P. Gaalaas	EE '62

Advisory Board

Dean S. C. Hollister

Technical Advisors

Prof. R. G. Thorpe
Prof. E. B. Watson

School Directors

Prof. N. A. Christensen	CE
Prof. W. H. Erickson	EE
Prof. C. C. Winding	ChemE
Prof. T. R. Cuykendall	EP
Prof. H. J. Loberg	ME
Prof. O. C. French	AgrE

Alumni

H. H. Williams, Jr.	B.C.E. '26
W. H. Hill	B.M.E '22
I. B. Margiloff	M.Ch.E. '53

Member of the Engineering College Magazines Associated

Chairman: Prof. Robert W. Bohl, University of Illinois, Urbana, Illinois
Publisher's Representatives, Littell-Murray-Barnhill, Inc., 369 Lexington Ave., New York and 605 N. Michigan Ave., Chicago

Why Vought Projects Bring Out The Best In An Engineer

At Vought, the engineer doesn't often forget past assignments. Like all big events, they leave vivid memories. And it's no wonder.

For here the engineer contributes to history-making projects — among them the record-breaking Crusader fighter; the Regulus II missile, chosen to arm our newest nuclear subs; and the new fast-developing 1,500-plus-mph fighter, details of which are still classified.

The Vought engineer watches such weapons take shape. He supervises critical tests, and he introduces the weapons to the men with whom they will serve.

Engineers with many specialties share these experiences. Today, for example, Vought is at work on important projects involving:

electronics design and manufacture
inertial navigation
investigation of advanced propulsion methods
Mach 5 configurations

Vought's excellent R&D facilities help the engineer through unexplored areas. And by teaming up with other specialists against mutual challenges, the Vought engineer learns new fields while advancing in his own.

★★★

Would you like to know what men with *your* training are doing at Vought . . . what *you* can expect of a Vought career?

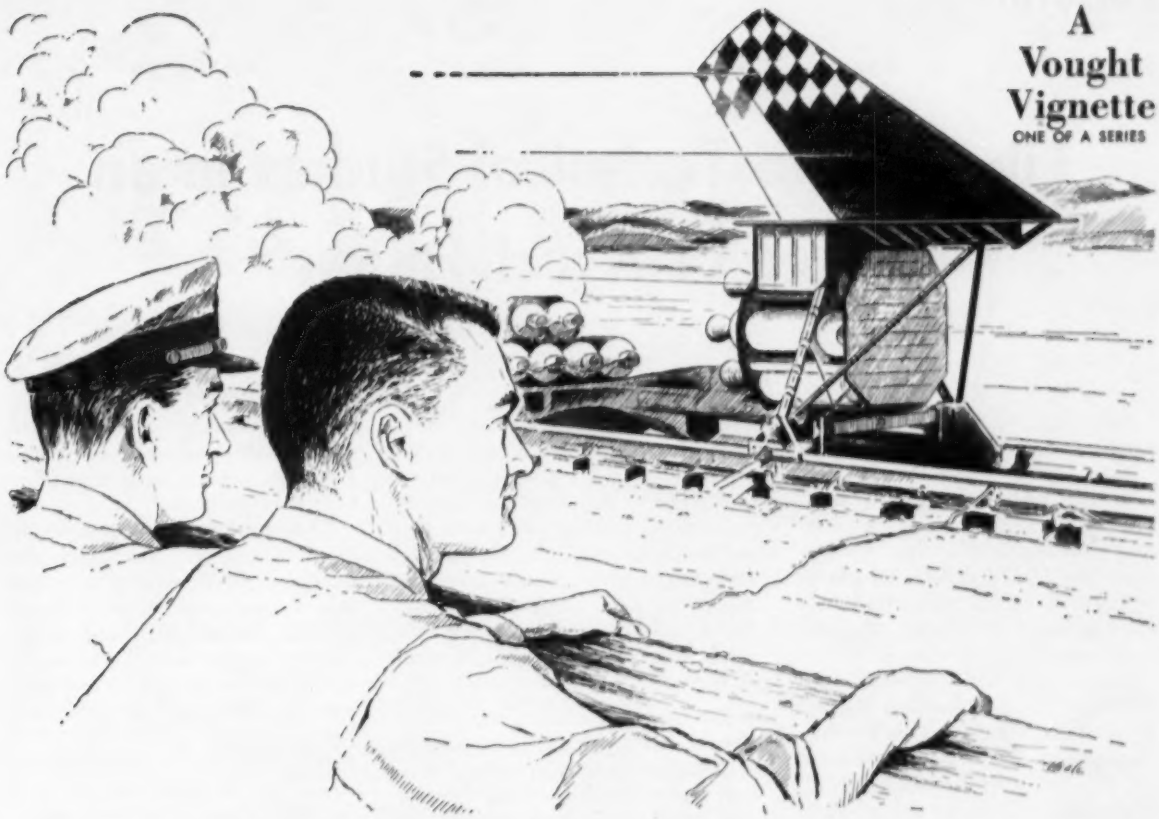
For full information, see our representative during his next campus visit.

★★★

Or write directly to:

C. A. Besio
Supervisor, Engineering Personnel
Dept. CM-5

CHANCE VOUGHT AIRCRAFT
INCORPORATED DALLAS, TEXAS



A Vought Vignette
ONE OF A SERIES

The structures engineer who found a fast detour

"Advise and assist on structural problems. Do what you can to keep the program moving . . ." With this outline of his liaison duties, Stress Analyst Ed Clay accompanied Vought's Regulus II missile to its desert test site.

On the desert, Ed found a dearth of structural problems. Regulus II reliability gave the flight test program tremendous momentum. In quick succession the missile notched 10 flights. When time came for a critical high-speed test, the program was three months ahead of schedule!

Then, the very fact that things had moved so fast threatened to rob the program of the time it had gained.

As Vought had planned, a wind tunnel flutter test had to precede the upcoming high-speed flight. But Vought's prearranged date at a government tunnel was over a month away. The facility was booked solidly up to the appointed day. And Vought's own Mach 5 tunnel was under construction.

Then Ed revealed the scope of his liaison. It had ranged to the rocket test track at nearby Edwards Air Force Base. There, with the help of a cooperative track project engineer, Ed had spotted a rusting rocket sled, left behind from a radome test. Now, if the sled could be rigged to carry that spare Regulus fin, Ed figured, they might get flutter data before the tunnel test.

That changed Ed's state of liaison. All Vought was suddenly at *his* service. Shopmen reworked the sled to mount the fin. Instrumentation technicians fitted the fin with gages and transducers. Vought's top flutter men double-checked, raised their eyebrows, then endorsed the whole thing.

At the track, moments before the rockets exploded, Ed had a twinge of doubt. His sled was a monster, indeed. Air loads would be terrific . . .

Then the sled shot off on the first of two successful trips that revealed all the data required.

At Chance Vought, there's liaison in spirit as well as in name. It allies engineers of many specialties and viewpoints against mutual problems. It builds channels instead of walls between diverse technical areas. It's another reason why top engineers are choosing Vought — *to keep abreast of all fields while advancing in one.*

CHANCE VOUGHT AIRCRAFT
INCORPORATED · DALLAS, TEXAS

Editorial . . .

Liberal and Technical Studies in an Age of Acceleration

"The Age of Acceleration" has joined the "Atomic Age" and the "Space Age" as a title for our time. Not only technical progress itself, but the increasing rate of that progress will remold the life of every man. The liberal and technical disciplines of higher education face the challenge of technological and social revolution previewed by two Sputniks and the Explorer. Students, teachers, and college administrators must prepare now to make changes on the campus adequate for the accelerated changes in all of living that will be fostered and coordinated by educated men.

In this issue of THE ENGINEER, liberal arts and engineering are evaluated by seven Cornell educators in order to define present objectives, and stimulate future planning of Cornell's role as a University. The weaknesses and strengths of both curricula should provide a basis for academic pioneering to meet the challenge of the "Age of Acceleration." Such pioneering can begin only if the purpose and philosophy of liberal and technical courses of study are better understood by the campus community. Such pioneering must begin if Cornell is to continue to be an educational leader in engineering and the humanities.

Education for the "Age of Acceleration" is not simply a matter of training more engineers and scientists, or of re-stating the platitudes of "humanizing the technical specialist" or "keeping a balance in education." The College of Arts and Sciences and the College of Engineering must recognize that mutual cooperation beyond basic math and science courses for engineers is essential to meet the problems Cornell graduates must face. Engineers need more liberal studies. Liberal arts students need to understand the implications of technology and the triumph of scientific discovery. Both liberal arts and engineering disciplines must avoid the peril of overspecialization; each must learn from the other in order to be of fullest value to the educated man.

Overspecialization, based on the notion that engineers can learn about the humanities on the side and that technology is too detailed and valueless for those educated to deal with "ideas," can create mass spectatoritis. Decisions turning on technical matters could be delegated to a group of insensitive experts whose power to change society could grow to dangerous proportions. The liberally educated specialist, incapable of understanding the overall significance of technical advance, could stifle the very progress capable of transforming many of the values he studies into realities. Such compartmentalized thinking, beginning in college curricula, can create a leveling off of judgment that undermines freedom of expression and political choice by destroying man's ability to criticize.

Unless the technical and liberal disciplines cooperate more fully on the college campus, science and technology can become idols worshipped not only by the technical specialist but also by the liberally educated mind. Such idolatry is fatal. It destroys the urge to develop new products to serve more men more effectively. It transforms humility, the root of scientific progress, into self satisfaction, the root of self destruction. It creates an aura of mystery and magic in which pseudo-scientific deceptions gain equal status with experimentally verified facts.

The future promises two revolutions—a technical revolution fostered by engineers and scientists, and a social revolution requiring the imagination and talents of liberally educated men. These revolutions are interrelated and inescapable. There will be problems of harnessing new kinds of power to perform new jobs in new locations. There will be problems of resolving differences in personal values, combating envy and selfishness reducing intolerance and ignorance.

Two revolutions requiring two kinds of knowledge demand greater unity between liberal and technical studies. Every deadwood shop course in engineering should be eliminated and replaced with required basic courses in the liberal arts. Every sequence of courses in engineering details should be compressed in a single course to allow more time for required liberal courses. Freshman engineers should be given greater guidance in planning their five year programs effectively, thereby enabling them to choose intelligently a related group of engineering or liberal electives. The senior project for engineers, equivalent to six credit hours, should be carefully re-considered in terms of its overall value in the five year program. Graduates with true professional competence will not result from a curriculum that pays lip service to liberal studies.

Similarly, the laboratory science requirement for liberal arts students is not enough. The claim that

(Continued on Page 66)

Founded 1885

THE CORNELL

engineer

MARCH 1958 VOLUME 23 NO. 6

Table of Contents

Editorial: Liberal and Technical Studies in an Age of Acceleration . . 10

THE LIBERAL-TECHNICAL CHALLENGE FOR CORNELL EDUCATION . . 17

The Objectives of Education 18
by Deane W. Malott, President, Cornell University

The Value of An Engineering Education 19
by S. C. Hollister, Dean of the College of Engineering

Education for the Free Man 20
by Francis E. Mineka, Dean of the College of Arts and Sciences

The "Complete" Engineer 22
by John F. McManus, Assistant Dean of the College of Engineering

Science for the Student in Humanities 27
by Henry Guerlac, Professor of History of Science

Non-Technical Requirements for Engineering Students 29
by Charles C. Winding, Director of the School of Chemical and Metallurgical Engineering

Intellectual Breadth Outside the Classroom 31
by Dexter Perkins, John L. Senior Professor of American Civilization

President's Message 40

Alumni Engineers 41

Professional Masters Degree 47

College News 50

Technibriefs 60

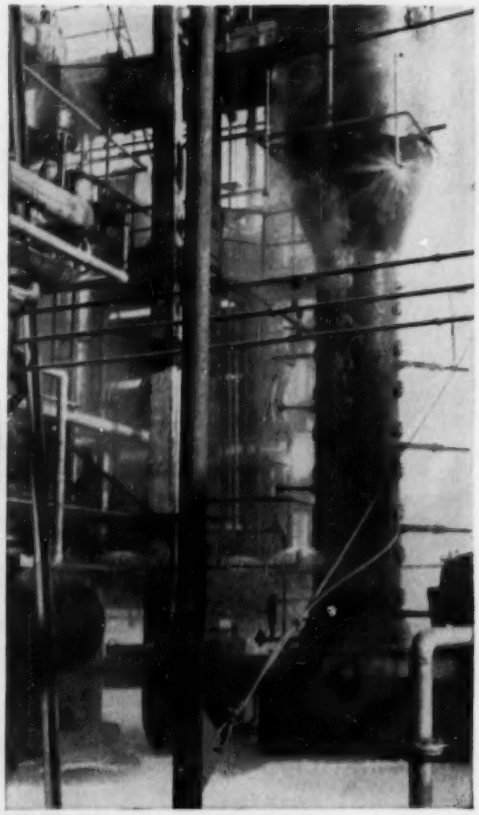
Stress and Strain 72

Published monthly—October to May—by the CORNELL ENGINEER, Inc., Carpenter Hall, Ithaca, N. Y. Edited by the undergraduates of the College of Engineering, Cornell University. Entered as second class matter at the Post Office at Ithaca, N. Y., under Section 103, Act of October 3, 1917.

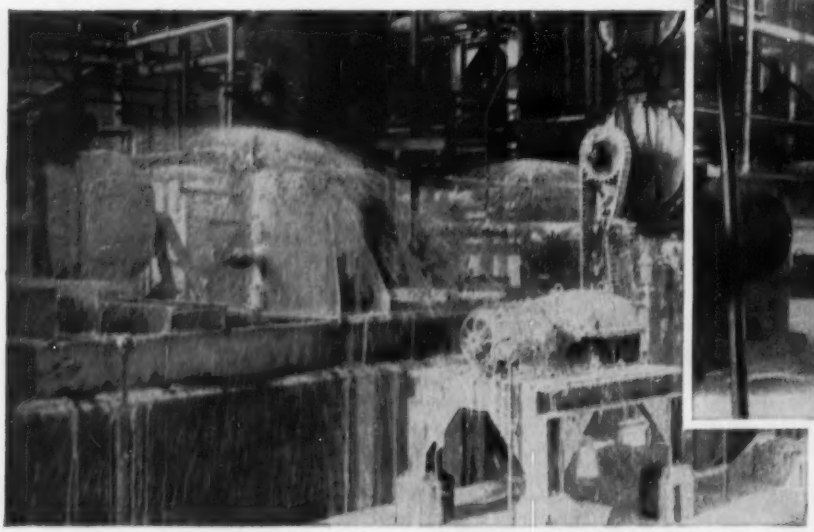
Subscription per year: regular $2.00; with membership in the Cornell Society of Engineers $3.00; student $1.50; single copy $.25.

Copyright 1958 by the CORNELL ENGINEER, INC.

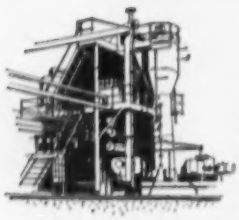
Tough Fire Protection Problem Solved by GRINNELL



▲ Grinnell ProtectoSpray on upper part of unit cools equipment and washes burning oil and solvent into area protected by foam blanket below.



▲ Grinnell ProtectoFoam safeguards the lower section of hexane solvent extraction unit with a blanket of foam, to prevent formation of explosive mixtures.



At Canadian Vegetable Oil Processing Ltd., Hamilton, Ontario, hexane solvent is used in extracting vegetable oil from soybeans. Because of the highly flammable nature of the solvent, Grinnell designed a special system for this unit, consisting of 162 ProtectoSpray nozzles — to drench the superstructure with fine water spray; and 24 ProtectoFoam spray heads — to blanket the diked area with foam. This water-foam combination protects the lives of personnel, as well as shielding equipment from costly damage.

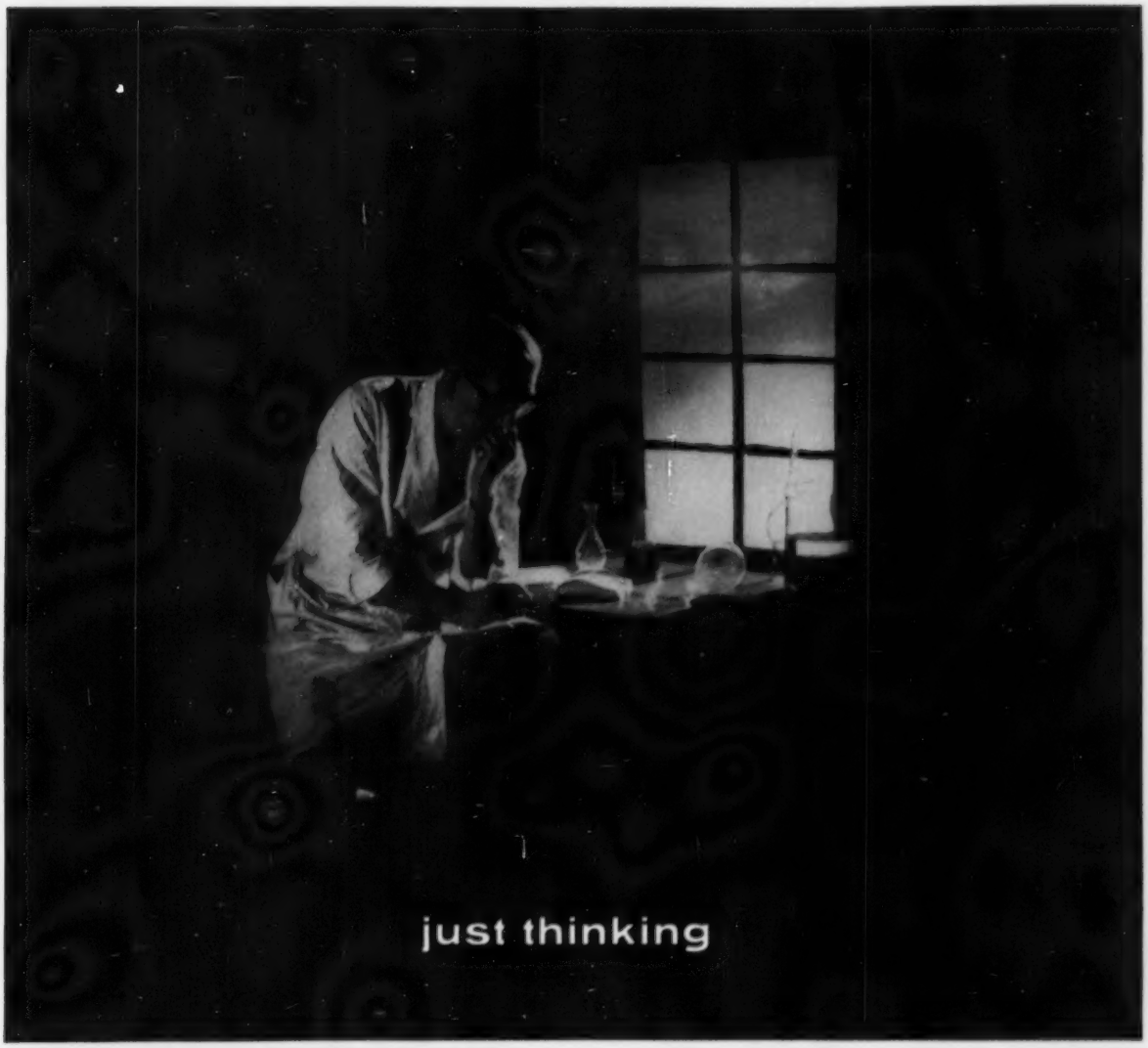
Solving tough fire problems like this with installations engineered to the hazard, tailored to the need, built of highest quality materials is something Grinnell has been doing successfully for more than 85 years.

Grinnell Fire Protection Systems include:

- Automatic spray sprinklers — wet pipe, dry pipe, Simplex, and deluge systems
- Emulsion and vapor dilution extinguishment with water sprays — Mulsifyre and ProtectoSpray systems
- Cooling, insulation and controlled burning with water sprays — ProtectoSpray systems
- Mechanical foam blanket — ProtectoFoam systems
- Carbon dioxide systems
- Dry chemical systems

Manufacturing, Engineering and Installation of Fire Protection Systems since 1870

ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL



Chemical progress is autoclaves, test tubes, distillation towers . . . hydrocarbons, heterocyclic compounds . . . processes, polymerizations, products.

But mostly, chemical progress is thinking . . . men thinking. Little men, big men, medium size men . . . in lab coats, business suits, overalls . . . all of them, always, thinking.

Thinking up new products . . . new ways to make chemicals and new ways to use them. Thinking up more comfort, more convenience, better health, for everyone.

Always, the old things have to be improved, and the new things have to be proved. It takes more thinking. The thinking never stops. And so chemical progress never stops. It's that way at Koppers.

You can be one of these men, thinking. You can create some of the chemical progress that's made at Koppers. The products are many . . . the opportunities myriad. Consider a career with Koppers; send the coupon today.

KOPPERS

KOPPERS CHEMICALS

Koppers Company, Inc.
Industrial Relations Manager
Dept. C-38, Koppers Building
Pittsburgh 19, Pennsylvania

Please send the 24-page brochure entitled "Your Career at Koppers."

Name .....

School .....

Address .....

City ..... State .....

"I'm in the business and I know..."

"Not too long ago I was in the same situation you fellows are in now. Senior year and the big decisions. What am I going to do with my education? What am I going to do for a living?

"Well, I talked to a number of people and did as much letter writing and looking around as I could. The way I figured it, I wanted opportunity . . . a fair chance to put my capabilities to work and to be recognized for what I could do. Of course, I wanted to be well paid, too. It all seemed to add up to the aircraft industry . . . and to me it still does.

"In the space of just a few years I've worked on quite a few projects, important projects that some day may mean a great deal to this country. They sure meant a lot to me. And I wasn't standing still either. My salary and my responsibilities have increased with each promotion. That means lots of challenges, new and tough problems that we have to solve, but that's the way I like it. So, if you want some advice from this "old grad," choose the aircraft industry. It's the wisest choice, I'm in the business and I know."

Probably no other industry in America has grown so fast *and advanced so far* in a short time as has the aircraft industry. And yet there is no limit to how far man's inventiveness and imagination can push the boundaries. Radical new concepts that would have been unthought of just a few years ago are the drawing-board problems of today.

Truly aviation is still in the pioneering stage, and one of the leaders is Northrop Aircraft, which has been making successful contributions to our nation's defense for over 18 years. Projects such as the Snark SM-62, world's first intercontinental guided missile, have identified Northrop as a successful pioneer. And new aircraft such as the supersonic, twin-jet T-38 advanced trainer are maintaining this reputation.

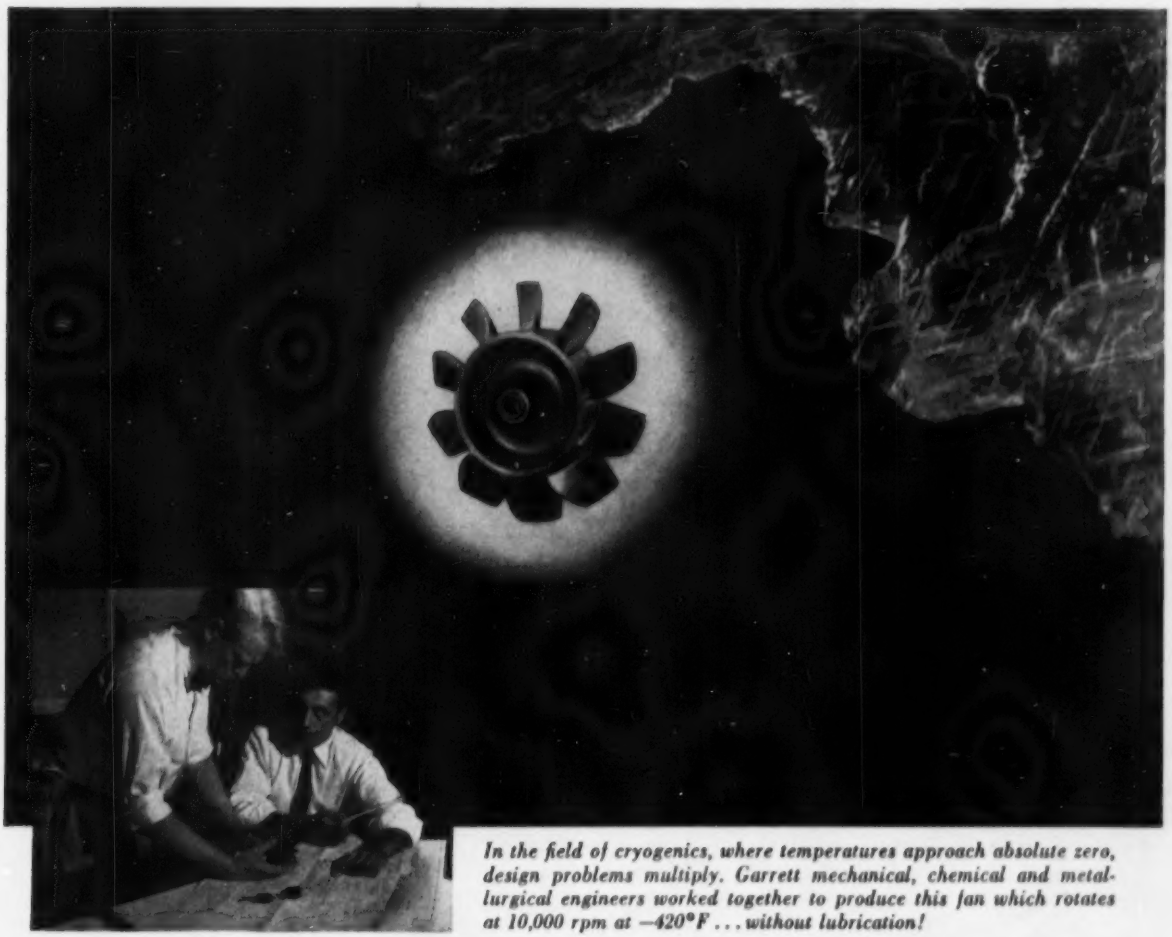
Let us tell you more about what Northrop can offer you. Write now, regardless of your class, to Manager of Engineering Industrial Relations, Northrop Division, Northrop Aircraft, Inc., 1034 East Broadway, Hawthorne, California.

NORTHROP

A Division of Northrop Aircraft, Inc.

BUILDERS OF THE FIRST INTERCONTINENTAL GUIDED MISSILE

Maximum results from a college education...



In the field of cryogenics, where temperatures approach absolute zero, design problems multiply. Garrett mechanical, chemical and metallurgical engineers worked together to produce this fan which rotates at 10,000 rpm at −420°F . . . without lubrication!

Education is the springboard for your future. Couple it with the proper engineering experience, such as you receive at Garrett, and you have the ingredients for a successful career in engineering fields which will be expanding for years.

At Garrett, specific opportunities in aircraft, missile and technological fields include: system electronics; computers and flight instruments; gas turbine engines and turbine motors; prime engine development; cryogenic and nuclear systems; pneumatic valves; servo control units and air motors; industrial turbochargers; air conditioning and pressurization and heat transfer.

In addition to direct assignments, a 9-month orientation program is available to aid you in selecting your field of interest. This permits you to survey project, laboratory and administrative aspects of engineering at Garrett. With company financial assistance you can continue your education at outstanding universities located nearby.

Project work is conducted by small groups where the effort of each individual is more quickly recognized and where opportunities for learning and advancement are greatly enhanced. For complete information, write to Mr. G. D. Bradley.

THE GARRETT CORPORATION

9851 S. SEPULVEDA BLVD., LOS ANGELES 45, CALIFORNIA

DIVISIONS: AIRESEARCH MANUFACTURING, LOS ANGELES • AIRESEARCH MANUFACTURING, PHOENIX • AIRSUPPLY
AIRESEARCH INDUSTRIAL • REX • AERO ENGINEERING • AIR CRUISERS • AIRESEARCH AVIATION SERVICE

THE LIBERAL-TECHNICAL CHALLENGE FOR CORNELL EDUCATION

- PRESIDENT DEANE W. MALOTT
- DEAN S. C. HOLLISTER
- DEAN FRANCIS E. MINEKA
- ASS'T DEAN JOHN F. McMANUS
- PROFESSOR HENRY GUERLAC
- DIRECTOR CHARLES C. WINDING
- PROFESSOR DEXTER PERKINS

The Cornell Graduate must create and be re-created as a result of his University education. His vocation and values must be unified to give his life broad meaning and purpose. How can Cornell cultivate the capacity for synthesis among its students?

THE CORNELL ENGINEER is privileged to present an analysis of the liberal technical challenge for Cornell education.

THE OBJECTIVES OF EDUCATION

by President Deane W. Malott

Deane Waldo Malott became the sixth president of Cornell University in 1951, the latest step in his career as teacher, businessman and university administrator.

For the 12 years before he came to Cornell, he was chancellor of the University of Kansas, his alma mater. Before that, he had been assistant dean of Harvard Business School, vice president of the Hawaiian Pineapple Company, and an associate professor at Harvard Business School.

A university is a composite—a complex of many things. It is a repository of knowledge, a great storehouse in its library system of the great learning, the ideas, the knowledge, emerging out of the past to create the whole culture of today; it is a stimulating, energizing center for investigation in the world of ideas and in their applications on a thousand research fronts; it is a transmission system for sending the high voltage of the latest in knowledge and ideas and thoughtful analysis into the generation of youth who are our students.

The common denominator of this congeries of activities is that cluster of disciplines forming the core of the liberal arts and sciences, those subjects which give breadth and purpose, idealism and imagination to our common humanity. Out of these disciplines are forged the essence of leadership—those qualities of power and of integrity, of curiosity and of tolerance which can make effective, in the minds and hearts of the possessor, the professional training of his choice.

An engineer without these qualities of leadership would be a scientific robot, unpredictable, ruthless, meaningless, in our society. A doctor, a lawyer, an architect, an executive, or a veterinarian similarly trained only in the techniques of his profession would be equally a blunder of educational procedure.

The purpose of the university, then, is to help create the whole person—able to think, to lead, of broad understanding—rather than merely to provide the techniques of application in a specific profession.

Cornell's initiative in adopting the five-year engineering program was an affirmation of this purpose.

There is no adequate measure of our success in approaching this goal. There is no criterion of success in measuring educational attainment. Some students acquire or develop these broad qualities of leadership; some fail to do so. Some seem focussed entirely upon material possession, or financial success; some pass through our doors at a very low rate of mental and moral metabolism—they just get by, leaving no impression on the university, and gaining little by their experience.

Clearly the university faces obstacles in the achievement of its goals. If its claim to greatness lies with the caliber of its students and its graduates—the kind of people they are and the dimensions of their roles in the world of today—we, like all other universities, must admit that we have attained something less than universal success.

Some would describe the fault as lack of money in the university's treasury, some would criticize the administrative efficacy of the enterprise, some would lay the blame at the door of the teaching abilities and counselling proclivities of our faculty. Yet despite it all, there are those who tread our halls to become great leaders, distinguished people, in the world of affairs.

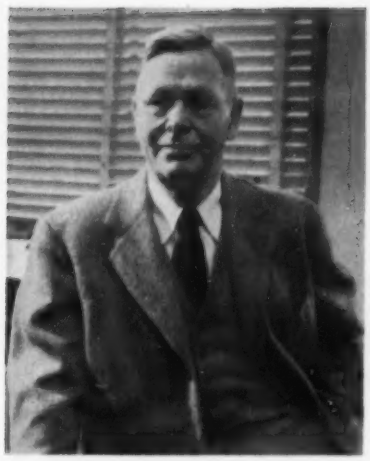
All of which leads me to be persuaded that individual drive, that subtle alchemy of personality and being, of which each one of us is composed, is the greatest factor in the success of our enterprise. We have distinguished professors by the score, adequately equipped laboratories by the dozen, our Library system is excellent; we have lectures, and music and art; we have extra-curricular activities to the number of nearly three hundred. The environment for stimulating experience and growth is available to each and every student. Some meet the challenge of these opportunities; they spend their money and time to purposeful avail.

Others go through the university, as I described it to one of the classes, like a marble in a pinball machine, jouncing along from one regulation to another, coming out

(Continued on Page 33)

THE VALUE OF AN ENGINEERING EDUCATION

by Dean S. C. Hollister



S. C. Hollister, Dean of the College of Engineering at Cornell, has become a foremost advocate of a strong engineering profession through the advancement of engineering education. His long participation in the activities of the American Society for Engineering Education culminated in the presidency in 1951-52.

Dean Hollister is active in government agencies and commissions. He is chairman of a group of technical advisors to the House Merchant Marine and Fisheries Committee which is investigating enlarging shipping accommodations at the Panama Canal or elsewhere. He was also a member of the second Hoover Commission.

Many people, without looking into the matter, assume that the liberal arts embrace only the humanities. This is not and never has been true. In the medieval universities liberal arts was comprised of the seven liberal arts, divided into two groups: a lower program called the trivium, and a higher program called the quadrivium. The trivium consisted in grammar, rhetoric, and logic. The quadrivium, the higher order, consisted in arithmetic, geometry, astronomy, and music. In those days these seven fields embraced the spectrum of formal education.

With the passage of time, the massive body of knowledge acquired in the sciences has developed into separate programs for science. The spectrum of human thought has similarly expanded tremendously in all fields. Historically, some of the greatest minds have been involved in the development of science and scientific application. The history of the development of human thought must necessarily involve such great intellectual achievements.

Man must be concerned with his environment as much as with his behavior in human activities. After all, he has to live in his environment. A knowledge of the environment and its adjustment to the needs of man is the business of science and technology. A liberally educated man must have some basic knowledge concerning the environment, and must understand the extent of achievement of human thought in this direction. This is as important to him as a study of the achievement of man in controlling individual and collective behaviors and in the development of thought processes.

The function of any program in higher education in its attempt to produce a liberal education is, first, to furnish a body of knowledge; second, to develop objectivity in thought; third, to develop the ability to think critically and rigorously; fourth, to develop the ability to continue self-education beyond the terminus of formal education. In the process a well-educated man should have acquired a balance between knowledge of the facts concerning our natural environment and understanding of the factors that control behavior among people.

A professional field in higher education has the joint obligation to provide for the objectives of higher education generally, and in addition, to educate for competence in the professional field. In engineering, a license is required for independent practice, otherwise a person must practice under the direction of one who does have a license. One cannot go from college to independent practice directly. The minimum time beyond college for such licensing is four years; usually it is longer. Higher education as a service to a profession of this sort has quite specific responsibilities.

The formal education necessary eventually to develop a well-educated man cannot be adequate if an introduction to pure or applied science is omitted, any more than it can be adequate if a suitable beginning is not made in the classics and the humanities. The "seven arts" embraced the *whole* range of intellectual activity. Only recently have interpreters erroneously attempted to restrict the liberal arts to the nonscientific subjects.

(Continued on Page 32)

EDUCATION FOR THE FREE MAN

by Dean Francis E. Mineka

Francis E. Mineka became Dean of the College of Arts and Sciences at Cornell last December after ten years with the University. He previously held the positions of Professor of English and Chairman of the Department of English. He is the author of "The Dissidence of Dissent". Dean Mineka is the Class of 1916 Professor of English Literature.

By derivation and tradition *liberal* education is education for the *liber homo*—the free man. Its purpose is to prepare men and women for lives of freedom and responsibility in a free, democratic society. Democracy must preserve its faith in the value of the individual or it may degenerate into mobocracy or totalitarianism. Liberal education seeks to provide society with individuals possessed of informed, critical, reasoning minds, educated rather than trained to "make a life rather than a living." Genuinely liberal education is scarcely possible in a totalitarian state.

The content of liberal education is to be found, to quote the Announcement of the College of Arts and Sciences, in "those subjects which, in the history of human civilization, have distinguished themselves as the means whereby man has come to understand himself and the world in which he lives." As presently conceived, a liberal education requires the student to gain a fundamental grounding in the humanities, the natural sciences, and the social studies, plus a more specialized knowledge of some major field of human understanding.

We have become accustomed to thinking of our world as a rapidly changing one. And so it is, with respect to the changes in the material conditions of our life as brought about by the ever-accelerating pace of developments in science and technology. Man's understanding and employment of the forces of external nature have grown immeasurably faster, however, than man's understanding of himself. The lag in the development of man's self-understanding is vastly more dangerous for the human race than any lag in the development of scientists and technologists.

America obviously needs to train more scientists, engineers, and technologists, but it must not forget that the best of such specialists are almost invariably those who are also in some measure liberally educated. The philosopher, Henri Bergson, once told a group of students: "Every one of us should begin, as mankind began, with the noble yet simple-minded ambition to know everything. . . . Here precisely is what distinguishes intellect from instinct and man from beast. The inferiority of the animal lies entirely in this—that it is a specialist. It does one thing to admiration; it can do nothing else."

The need of providing students at least some measure of liberal education is recognized by all the undergraduate technical or professional colleges at Cornell. Some of these colleges themselves make direct contributions to liberal education by offering courses liberal in purpose and content—one thinks at once of such courses as those in Fine Arts in the College of Architecture or Professor Konvitz's course in American Ideals in the School of Industrial and Labor Relations. In the main, however, the responsibility for providing liberal education for technical and professional students is delegated to the College of Arts and Sciences.

The responsibility is a very considerable one. The Arts College in addition to providing for over ninety per cent of the instruction of its own 2,800 students provides in-

struction for the equivalent of 1,700 full-time students in the other colleges. Somewhat over forty per cent of all instruction for engineering students—including their basic courses in mathematics, science, English composition, and various electives—is given in the Arts College. The College provides approximately one half of all the academic instruction in the University.

This is not to say that one half the instruction in the University is always genuinely liberal education. Some departments have perhaps not always been wholly innocent of encouraging the vocationalizing of the Arts course. And among Arts College students themselves there is far too frequently a tendency to "professionalize" and over-specialize in their studies, rather than to gain an education broad as well as deep. Graduate professional schools such as those in medicine and law have consequently tried to discourage pre-professional students from warping their liberal education by premature specialization.

In many large universities the Arts College seems to be regarded by the other colleges mainly as a "service" institution in which the basic tools—English, mathematics, science—are provided to the technical and vocational students. In such situations the Arts College invariably suffers both in quality and esteem. Fortunately, this has not, I think, been true at Cornell. The College of Arts and Sciences is properly honored in the University as a distinguished College which pursues its own distinctive goals for its own students, but which also pursues those same goals for the students of other colleges who enroll in its courses. The College makes no distinctions between its students and those of other colleges. With very few exceptions, the College does not offer special courses or sections for engineering, agriculture, or home economics students. Is there any reason, for instance, why a freshman engineer really needs or should have a different course than the Arts freshman in that most difficult of skills, the writing of clear, decent English prose? The English Department does rightly section students according to ability in its freshman composition course; it does not segregate students into groups according to their respective colleges.

Arts College students can obtain —and many do—a first-rate liberal education at Cornell. That they do not always get such an education can be attributed to a variety of causes, chief among which are: overprofessionalizing the course of study, overindulgence in social and extra-curricular activities, indolence, and lack of genuine intellectual purpose and curiosity. The roots of these difficulties lie in American society and its conception of a college education. Not until that conception undergoes serious change—not until we as a nation develop a serious respect for the intellectual life—will there be real improvement in the intellectual climate of American colleges. But in the meantime the college should do everything in its power to produce a climate that will foster the desire for intellectual cultivation and distinction.

At Cornell the non-Arts student can also obtain—if he will—at least the rudiments of a first-rate liberal education at the same time that he is acquiring his technical education. Too often, however, he does not get what ought to be regarded as the minimum of liberal studies. Too seldom does he take Arts courses that may be of importance to him as a person, rather than as a specialist. The engineering student, for instance, does get a generous amount of basic science and mathematics, both of which are an important part of a liberal education, as well as of a technical education, but he seldom receives the exposure to courses in the humanities, history and the social studies that Arts students receive by virtue of fulfilling the requirements of the Common Studies program. The adoption of some similar program of Common Studies by all the undergraduate colleges in this University would be an important forward step in the improvement of liberal education at Cornell.

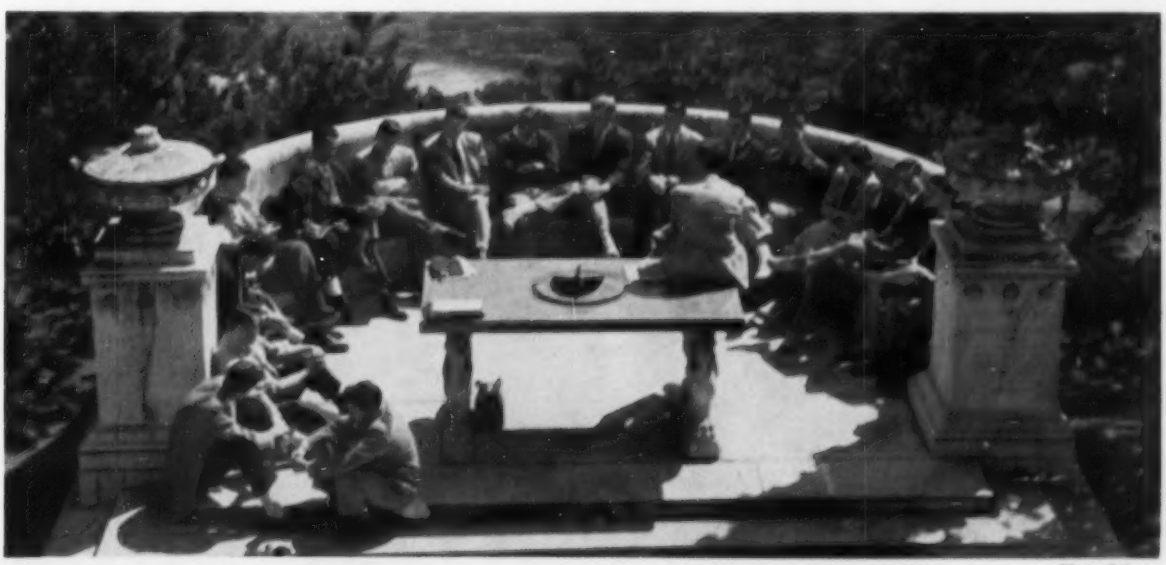


Photo Science

Courses in liberal arts are of basic importance to every student. Such studies help the individual to take his place as an enlightened member of society. Free discussion and exchange of ideas are one of the basic ingredients in a liberal arts training.

THE "COMPLETE" ENGINEER

by Assistant Dean John F. McManus

John F. McManus received the C.E. degree from Cornell in 1936. His first period in professional engineering was with the Eastman Kodak Company as structural engineer on design and construction of manufacturing and chemical processing buildings and equipment.

In 1941 he was appointed resident director of the Engineering, Science and Management War Training Program established by Cornell for industry in the Buffalo area.

He returned to Cornell in 1948 as assistant to the Dean of Engineering, and since 1956 has been Assistant Dean of the College.

"As no man is born an artist, so no man is born an angler."—Isaak Walton ("The Compleat Angler")

It may seem facetious to extrapolate from the angler to the engineer, but certainly Isaak Walton's succinct observation on the need for learning in what may seem to be an elemental skill has been amplified much more ponderously in recent years concerning the engineer and his complex world. Obvious as it may be that the engineer is made, not born, a great confusion of words obscures the formula for his making, and indeed the very mold into which he is to be shaped. Perhaps as a prelude to further words on the subject it may be well to recall the basic and simple objective of engineering education, and that is to prepare practitioners for a highly demanding profession.

Unfortunately such an unadorned statement is not sufficiently definitive to prescribe a universally acceptable pattern of education for something that is at once as specific and as amorphous as engineering.

For almost a century engineering education was concerned primarily with teaching a body of solid, impersonal, physical fact. In recent years two opposing pressures have been building up: first, to expand the scope of scientific and technical knowledge imparted to the engineering student, and at the same time, to "liberalize" his education by including a body of humanistic and general studies in his curriculum. With four years of undergraduate work as the traditional plan, engineering education faced a formidable task of reorganization—one that is by no means completed.

The whole matter is complicated by some haziness as to what is to be accomplished. Can the engineering student be taught all of the continually expanding volume of technical knowledge, and even if possible, will this be sufficient to carry him through a professional life of the next thirty or forty years? Can he at the same time become sufficiently steeped in philosophy, history, literature, the arts, psychology, government, economics, sociology, to influence for the better his service to society and enrich his personal life? Both questions supply their own answers: the simple addition of subject matter into an accumulating mass is impracticable in terms of time and unproductive in terms of intellect. Some kind of selected and related material must be woven together for an economy of time, comprehension, and utility.

In the technical area there is reasonable agreement that engineering curricula must depend primarily upon broadening the base of fundamentals, from which the engineer may build in whatever direction his career may take him. The same principle would seem to be sound for his general or liberal education, but the means of achieving this is not always clearly conceived. Here, perhaps even more than in his technical studies, the inspirational qualities of his experience will determine the long-time effect. Whatever time it may be possible to allot to liberal studies in an engineering curriculum, it will never be possible to achieve more than an appreciation—a stimulation toward continuing exploration and development throughout life. Achievement of this attitude is the real challenge before a liberal program in an engineering curriculum.

There is, in fact, no conflict between the objectives of a technical and a liberal education. A recent

editorial in *Life* makes this point:

"As late as a century ago the study of 'literature' embraced works which included natural history, philosophy, art criticism and pure science, e.g., Sir Isaac Newton and Robert Boyle. But by the end of the 19th Century, as science grew more complicated, it lapsed into its own specialized language, making little effort to reach the layman. Concurrently, the 'art for art's sake' school began self-consciously concentrating on the *shape* of literature rather than what it said, on the metaphor instead of the meaning.

"The result is that several generations have been brought up to think of 'literaure' as a novel, an essay or a poem, and science as something you can only study in the laboratory (if you want to make the effort). In other ages scientific discovery deeply affected the literature of its time, from Alexander Pope through Emerson and Whitman. In our own time, although the discoveries of science have built a new dimension to man's imagination, they have hardly been deemed worthy of 'literary' comment. Our culture is still 'prescientific.' When Rachel Carson's *The Sea Around Us* came out in 1951, it startled the critics precisely because it combined good science and good literature."

Technical and liberal education have come to be regarded as separate and even incompatible pursuits in the minds of many, so that too often a liberal program is viewed as a kind of antidote rather than an additive to an engineering education.

Quotations can be found to support almost any position, of course, but perhaps another is permissible here—this one from the Williams College Bulletin:

"The ideal product of this type of college, the so-called 'liberally educated man,' is difficult to define because he does not conform to any fixed pattern. Indeed a respect for individuality is the starting point of a 'liberal' education. It is hoped that a student who has graduated from Williams will be aware of uniqueness—the value inherent in convictions, tastes, and opinions which are the result of disciplined but independent investigation.

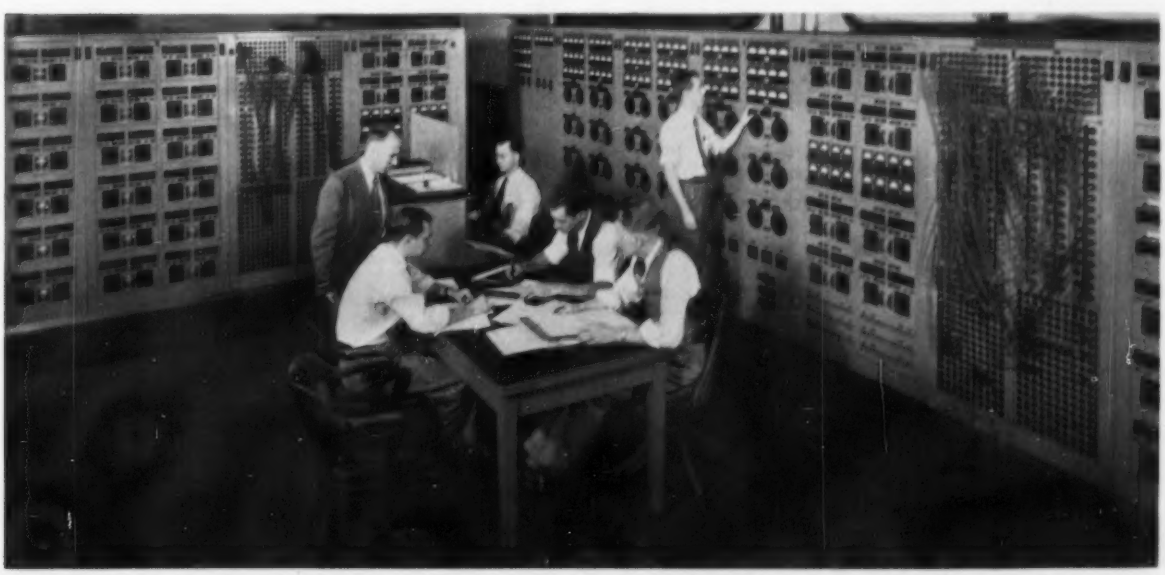
"The members of the Williams faculty and administration also believe, however, that the 'liberally educated man' is someone who is capable of objective, unbiased thinking, who can organize his thoughts effectively and express them with clarity, and whose powers of judgment enable him, when faced with a particular problem, to distinguish between essentials and inessentials, between relevant and irrelevant points. Although he is well informed, he knows that mere information is of little value unless it is the adjunct of a mind which is devoted to excellence in all branches of human endeavor—intellectual, aesthetic, and moral."

This would be equally commendable as a statement of the objectives of engineering education.

Various proposals have come forth for the adjustment of engineering education to this broad purpose, but it is probable—and perhaps desirable—that an absolute answer will always be elusive.

One of the first specifications was for the assignment of about twenty per cent of the total time in an engineering curriculum to non-technical courses. This has had various interpretation, ranging from humanistic to business management courses, and from a fixed program and sequence of courses to a completely elective program. Most efforts probably have been somewhere in the middle ground.

Since most engineering schools in this country are still committed



One of the important advantages of attending a large University is the technical equipment one has at his disposal. This network calculator is one of the many complex pieces of apparatus at the disposal of the Cornell student.

to a four-year undergraduate program, the opposing pressures for an increase in both technical and non-technical content have produced a difficult problem, one that is further complicated by variations in the admissions base among schools. This has led to a growing concentration on fundamentals in the technical area, and a decline in the study of engineering applications, and even some decline in laboratory work. In effect, an additional compromise has been made in many cases—the channeling of students into relatively narrow specialties or options, since the restricted time does not permit broad coverage of even one of the major branches of engineering.

Most four-year curricula have not been able to include a full twenty per cent of non-technical work. A random sampling of a number of representative institutions shows the non-technical required courses and electives ranging from ten to fifteen per cent of the total hours. It is usual also to include within this group courses in economics, business administration, and report writing as well as the humanities. The latter are often set up as required electives with a certain pattern of choice stipulated. Required English courses are often of the proficiency requirement type, with literature as an elective. Other courses which appear most frequently in the approved elective lists are social science, political science, psychology, history, Western Civilization, anthropology, life sciences, philosophy, and the fine arts. Foreign languages also appear, but there seems to be relatively little pressure to establish proficiency in a foreign language as part of an engineering curriculum.

In the past decade various plans have developed for the combination of a standard liberal arts curriculum and an engineering curriculum, generally leading to two degrees. For the most part these started as cooperative arrangements between small liberal arts colleges and institutes of technology, although some engineering schools in universities also participate.

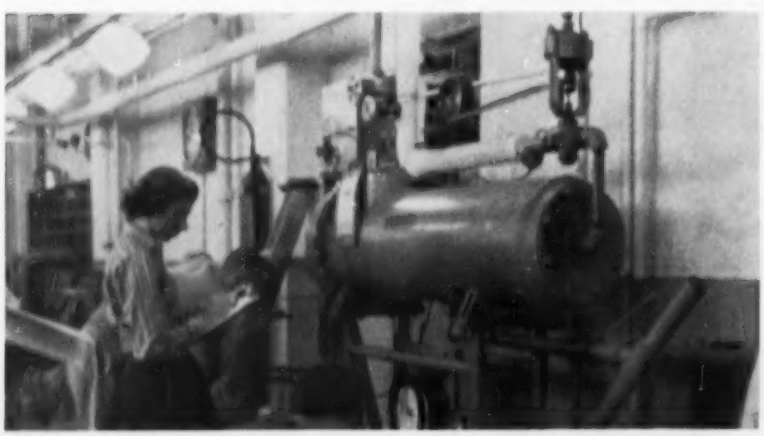
Generally the plan is for the student to spend three years in the liberal arts college and then two years in a cooperating engineering school. If successful, at the end of the five years he receives the bachelor of arts degree from his original college and the bachelor of science (or engineering) degree from the second institution.

In evaluating such programs a number of factors need to be considered. Certain features of the plan are undeniably attractive. The student takes his initial work in a small liberal arts college, often one with an excellent reputation, offering him study in a traditional cultural environment, with a student body and faculty of single purpose. He then moves into his professional program when presumably he is more mature and has developed a broad intellectual background. Proponents of this plan also point out that many high school students are not ready to make a decision on a professional career at the beginning of college and that the three-year preparatory period provides an easier transition into engineering. In this period those who change their objectives from engineering can readily go on in some other field with little or no disruption of their education. Some who take an even broader view feel that this arrangement will make it possible for the nation to use its educational facilities more efficiently and to greater capacity particularly if a greater number of engineers are to be trained.

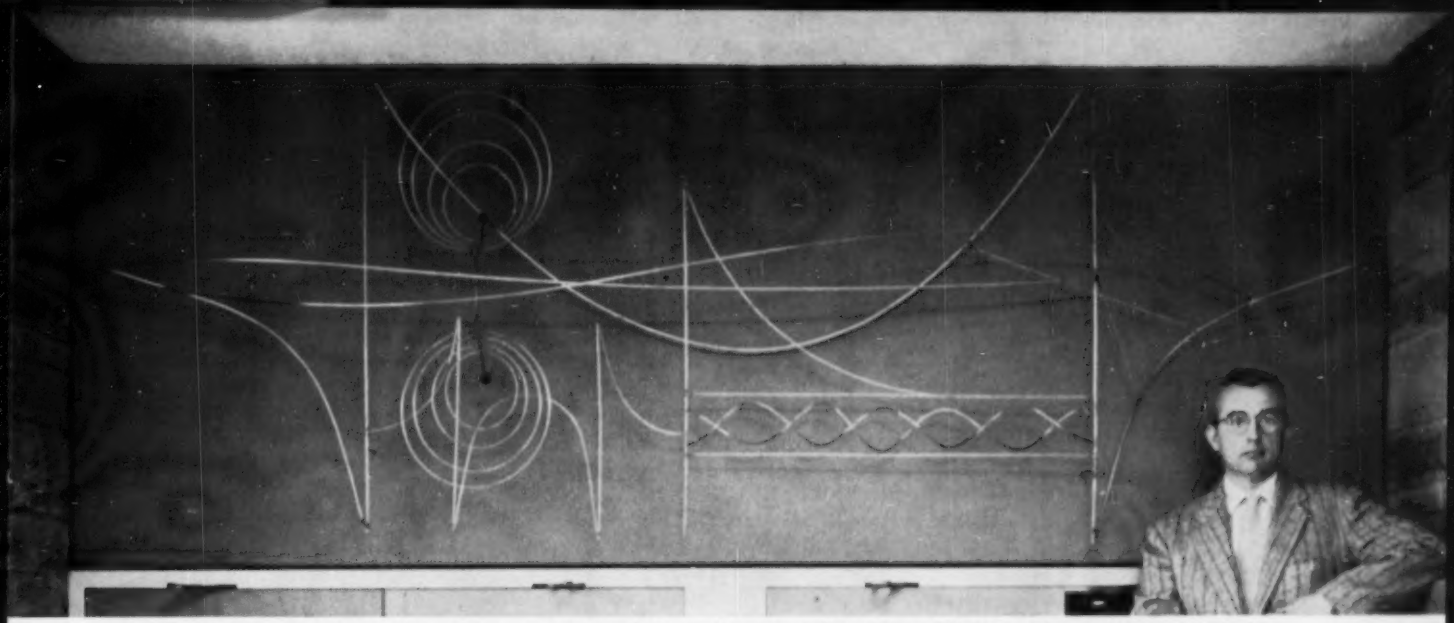
There is, however, another side. The three-year period at the small liberal arts college is a mixed blessing if the student then transfers to the large engineering college. The three-two program is likely to appeal to superior students and such students are likely to make a substantial place for themselves in the small college in this three-year period. This means that the student who is likely to be in line to be the next president of the Student Council, or of his fraternity, or captain of his team, or the one who has just become very much absorbed in his academic program, is required to uproot and move to an entirely new and strange environment. Actually it appears that many such students are reluctant to do so and prefer to stay on in their initial program. In fact, some of the liberal arts colleges who participate in this plan are now suggesting that the student give serious consideration to completing his full four years in the college before moving on to his professional study.

This, then, becomes a four-two program leading to two bachelor's degrees with six years involved. The student has a more serious decision to make, for if he started immediately on his engineering program he might be well on the way toward one or more advanced degrees in this period of time.

What of the quality of education he receives in the three-two program? As already remarked, he may receive a very fine education in the liberal-arts college. In his first three years, however, he will ordinarily take a lighter load in terms of credit hours than he would take in a similar time in the



With the Chemical Engineering curriculum involving a large number of laboratory courses, the school found it necessary to increase its undergraduate program from four to five years. The Chemical Engineering School was the first to undertake the five-year program.



Art has joined engineering in this relief construction made by Prof. Victor Colby of Cornell for the university's new electrical engineering building. Figures from diagrams of basic electrical concepts make up the design—the M-shaped figure reaching from side to side is used in describing magnetic fields, the two sets of circles are in diagrams of magnetic flux around parallel conductors, and the other figures appear on an oscilloscope.

engineering school. Furthermore, in order to step into the last two years of engineering he would probably have to major in science in his first three years. With perhaps three of his five courses per semester necessarily devoted to science, and with possibly a language requirement to be accomplished in this time also, relatively little time is available for a broad range of liberal studies, unless he is permitted some additional electives and can handle them.

As for his science preparation, this, too, can be excellent, but it probably will be lacking in some of the engineering sciences such as mechanics, properties of materials, fluid mechanics, thermodynamics, etc. Complete unfamiliarity with the engineering utilization of basic science may put him at a considerable disadvantage when he enters the upper-class professional courses in the engineering school.

There is the further question of the relative effectiveness of placing the liberal studies at the beginning of the collegiate program rather than introducing them throughout an engineering curriculum, or even placing most of them near the end of the engineering studies. Educators who favor the latter plans make the point that the student can gain a more mature appreciation of the liberal studies toward the latter part of his professional program, and that they are particularly more effective at this point in relating his professional career to the world about him.

Another factor that will give pause to some students is that there is no assurance of acceptance into the engineering college at the beginning of the three-two plan; application for transfer ordinarily is considered during the third year of the liberal-arts program.

A number of other aspects of this type of program could be explored at length and there is no question that the possibilities of various combined programs are intriguing to educators. As developed to the present time, however, it must be doubted whether the advantages of the three-two program outweigh the disadvantages, especially in terms of the disruption in the student's collegiate life at a critical point, and in terms of whether the total educational result, both technical and liberal, is superior to a well-structured engineering curriculum with sufficient provision for general studies.

Where an engineering college operates as part of a large university, the opportunities for the integration of a substantial general program with the technical program are especially fertile. Nevertheless such engineering colleges, and this is certainly true of Cornell, are very much interested also in the possibilities of superimposing a sound engineering education in a reasonable time on a standard liberal arts program for transfers or graduates coming either from within the university or from other institutions. Careful study is being given to such possible programs.

The five-year engineering curriculum is sometimes thought to be simply a three-two program within a single institution but this is inaccurate. Whereas the three-two program is essentially intended to provide a base of liberal studies, and especially liberal studies in a college of liberal arts, the five-year curriculum as developed at Cornell is intended to strengthen both the scientific-technical sequence and the liberal core. The three-two program aims for the same professional end point as the regular four-year engineering curriculum; in fact, one of the problems involved in this program is to bring the student far enough scientifically and technically in the first three years to enable him to step into the third and fourth years of the regular engineering curriculum.

It is important also that the five-year engineering curriculum provides a substantially greater number of total hours than would ordinarily accumulate in the three-two program. Consequently the five-year period not only provides time for the development of a sequence of general studies, but it also makes possible a better sequential arrangement of the technical studies, so that the later engineering

courses can be based more solidly on prerequisites.

The first five-year engineering curriculum at Cornell was that in chemical engineering, established in 1938. Subsequently all other Cornell engineering curricula were extended to five years starting in 1946. Since that time the faculty has been engaged in a continuing study of both the technical and liberal content of the program and a number of adjustments have been gradually introduced.

It is one of the traditions at Cornell that the separate schools of engineering should have considerable latitude in curriculum development of their own fields, within the general framework established by the college faculty. This has permitted certain experimentation in a number of directions, including that of liberal education for engineers.

Initially the five-year curricula provided for a fairly well prescribed group of non-technical courses. With the great wealth of studies available within the University, and with the broad range of interest exhibited by engineering students, a trend towards greater freedom in the choice of liberal studies through electives gradually developed. However, the College does not believe that a casual cafeteria selection of non-technical courses can produce the broad intellectual and cultural effect desired and therefore a certain basic plan is necessary for this area of studies as it is for the technical studies.

One plan is illustrated by the requirements in electrical engineering. With forty-five elective credit hours in the curriculum (out of a total of 170), twenty-seven must be non-technical, nine must be technical, and nine are completely free. In addition, six hours of English are required. Thus the student can take a total of forty-two hours of non-technical work. In order to insure some breadth of liberal studies, and to develop also some reasonable depth in this field, the student is required to choose his electives from at least three of five major groups of courses, and then to build a sequence in at least two of these three groups. The remaining elective hours can be utilized outside of his primary plan. In many respects this reflects the pattern of the program in the College of Arts and Sciences.

The possibilities available to students in five-year engineering programs at a university-affiliated engineering college such as Cornell are illustrated by a recent tabulation of the enrollments of engineers in departments outside of engineering. A typical tabulation for Cornell engineers shows them enrolled in astronomy, economics, English, Far Eastern studies, fine arts, geology, government, history, literature, modern languages, music, philosophy, psychology, sociology, speech and drama, zoology, architecture, business and public administration, law, agriculture, industrial and labor relations, as well as the required courses in mathematics, physics, and chemistry.

This is not to imply final satisfaction on the part of the College with the engineering curricula in respect to either the technical or non-technical programs. In fact, education for a field as dynamic as engineering can never be completely crystallized. It is the tradition of Cornell engineering that it should not only keep pace with the development of the profession, but that it should provide leadership for such development. With this view, which has had its most tangible recent expression in terms of the five-year curricula, it can be expected that continuing study and adjustment of all phases of the program for Cornell engineers will be carried out.

Reference has been made to the interest of the College of Engineering in developing combined study plans in liberal arts and engineering, both within the University and in affiliation with other liberal arts colleges. A study is currently under way to determine the feasibility of a six year, two degree, arts-engineering program at Cornell. The purpose is to accomplish this without compromising the full requirements of either division. It is a relatively easy matter to accomplish this for a liberal arts student majoring in science, particularly physics, but it is a further purpose to make it possible for the humanities major. With proper use of the elective allowances in both divisions, and possibly with some increased load in the earlier years, it would seem that a satisfactory program could be worked out for individuals.

Here again, of course, the student is faced with the choice of spending six years for two distinct baccalaureate degrees, or using this time towards graduate degrees in a single program.

Ultimately it may be that engineering will become a professional or graduate program on top of a general preparatory program, such as has developed in law and medicine. Whether the profession can afford the time and expense of such a program for the great mass of its practitioners is a serious question. Perhaps one day the truly professional engineer will be part of a relatively small elite group with this kind of superior background, supported by a large group with essentially technician training. Even if this should come about, however, there will almost certainly be two conflicting philosophies for engineering education: the preparatory-professional type program as opposed to the straight professional program leading through a series of undergraduate and graduate degrees. The increasing assignment of engineers to non-technical responsibilities in business, finance, government, on the one hand, and the growing complexity of scientific and technical responsibilities on the other will continue to make more difficult the development of any single educational pattern that will satisfy all of what we should like to accomplish in engineering education.

The student who may question the stability of his education when so many divergent views seem to be appearing should be reassured that it is characteristic of a dynamic educational philosophy that it is always seeking—that there is never complete satisfaction or complacency. It is important that the primary responsibility of engineering education should not be obscured, and that is to prepare the student for his professional responsibility as an *engineer*. Perhaps it is difficult to define just what an engineer is and even more difficult to define what he does. Whatever opportunities may come before him

(Continued on Page 33)

SCIENCE FOR THE STUDENT IN HUMANITIES

by Professor Henry Guerlac

Henry Guerlac was appointed Professor of History of Science at Cornell in 1946. History 165–166, ***Science in Western Civilization,*** *taught by him, is a very popular course among Cornell students.*

A Cornell alumnus, he received his B.A. degree here in 1932 and his M.S. in 1933. Since then, he has been historian of the MIT Radiation Laboratory and assistant professor and chairman of the history of science department at the University of Wisconsin.

Much has lately been spoken about the need to recast the curriculum of engineering and science students to include more social studies and humanities. Sometimes, and with justification, a scientist or engineer retorts that the reformers are one-sided and fail to point out that the budding humanist needs some comprehension of science fully as much as the science student needs some knowledge of history, literature and the behavioral sciences.

Yet I do not think the situation is quite so simple or so symmetrical as first appears. If I were asked the blunt question: does the nonscientific student need an exposure to science as much as, or in the same way as, the scientist or the engineer needs some humanistic preparation? in all honesty I should have to say no. And for a simple reason: for most university students today a knowledge of science, while eminently desirable, can serve in the main only a cultural purpose; it can inform him more or less about the activities of a tremendously influential and highly specialized minority (or elite, if you will) who—if we take literate mankind in the large—are destined to remain a minority, oddly aloof and increasingly incomprehensible to their fellows.

A humanistic education, on the other hand, is for everybody about everybody. It is the essence of humanistic study that it deals with man, and more particularly with those human problems—aesthetic, moral, political, economic and religious—which are, and will always remain, the true concern of the majority of human beings. Its chief stock in trade is the world's accumulated wisdom—and its recurrent miscalculations—about the potentialities and the accomplishments and the foolishness of men. At its best, it leads to tolerance and understanding of those who live differently from us; it increases our respect for accomplishments that transcend our own; it links us with the human family; and it leads us to value and comprehend those predecessors in history who paved the way for our transient passage on this earth. In a word, it is education to join the human race. What, in the broadest sense, could be more practical?

Yet, though I think a reform of the engineering curriculum more urgent than the one advocated by my scientific friend, I strongly agree with the point he intends to make; and this is that a person totally ignorant of what science is about (and I mean scientific discovery, rather than technology) is ill-equipped to understand the modern world in which he lives, to say nothing of the last two hundred years of the world's history. Indeed I strongly feel that science should be a part of the liberal education of any college graduate, not only because it will help to orient him in modern life, but because he ought to know about it on his own terms and for his own purposes. Scientific accomplishment is a part of our humanistic heritage, the work of some of the finest men and women of our race. And the method—or at least the attitude of mind—with which the scientist has learned to unravel some of the mysteries of the natural universe, has come to exert a great influence—as the supreme model of successful intellectual accomplishment—over the humanist's own efforts to learn more about man. At best he successfully translates the scientist's spirit and "method" into his own study of history, of primitive society, of contemporary life and politics; at worst, he produces nonsense decked out in pseudo-scientific garb. It were well to distin-

guish the true product from the fraudulent. Some study of science will give him a standard of comparison.

Every planner of curricula—since the unlamented days of free electives—has accepted as a working principle that every student, in an age such as ours, should know something about science. In all universities there is some sort of basic science requirement which the student must satisfy before graduation. Most commonly—though there have been some bold experiments of late—this consists in requiring the student to pass six hours of an elementary course in a laboratory science. Usually this is not the same as the introductory course offered to prospective concentrators in the field. This is Cornell's solution to the problem. Let us examine with some care the situation in a mythical but not untypical sister institution, Utopia State College.

The required science courses at Utopia are mainly *fact* courses, in which the lecturer introduces the student to the private jargon and some of the general concepts of the particular science, and to a good deal of miscellaneous information. In the weekly laboratory session the student learns that the scientist studies nature directly, not merely through books; he makes some simple measurements or some easy experiments; he learns to draw what he sees (and hence learns to observe with discrimination) and by entering data or drawings in a notebook is taught something about scientific housekeeping.

These courses are not intended to fire the student to pursue further the study of science. They are in most cases "terminal." Yet quite unabashedly they are simplified versions of the pre-professional courses. Some of the detail is missing, some of the tougher problems are omitted, but the outline and the general content is much the same. Because of this, a good deal that is taught can acquire meaning and value only if the student goes further in the subject, and this he is not expected to do. Small wonder that the students at Utopia dislike these courses, and that the younger science professors pray that they will not be asked to give them. Something is clearly wrong here.

To see how unsuited such a course is to its captive audience, let us look for a moment at a reasonably intelligent specimen of the "non-scientific" student. By definition he has avoided science, and thinks he has little aptitude for it. He is not as interested in *things* (not even cars and clothes) nearly as much as he is in people and ideas. He is hopelessly clumsy with his hands in matters mechanical, and makes quite a to-do about replacing a fuse in his mother's cellar. But he has read a good deal, writes English with tolerable skill, can enjoy Stendahl in the original French without difficulty, and has been worrying of late about the Middle Eastern policy of John Foster Dulles. He chose to satisfy his science requirement with Biology I (physics was "too hard" and chemistry was "too messy") but he emerged bored, virginal, and victorious with a grade of C—.

By contrast with the young "non-scientist," the interest of the scientifically-minded student often develops out of a curiosity about *things-for-themselves*: the mystery of his father's automobile or television set, the rocks and minerals picked up on camping trips, the hamster he had when he was a kid. But as he does not remain a mere naturalist or gadgeteer, he gradually comes to be as interested in *ideas about things* as in the *things-for-themselves*. But the young "non-scientist" does not start with this intrinsic interest in things, or—except rarely—with much manual skill. His chief concern is with human beings; perhaps with himself, first of all: the functioning of his mind and the problem of human personality; but he is also deeply interested in the society around him, how it operates and where it came from. He has read and thought a good deal about these things and, paradoxically, he has advanced further in the delicate task of handling abstract ideas—many kinds of abstract ideas—than his scientifically oriented young friends. It is through his interest in ideas and in human beings that he must be approached, if we are to interest him in science. We cannot assume in him that concern with things-for-themselves that he does not possess, nor hope to rally him with that form of adult play which makes up so much of elementary laboratory instruction.

What then is the answer? It is, I think, to *humanize* the teaching of science for the non-scientist, and to do this, not by making the courses easier, but by giving them a new direction which, in certain ways at least, will actually make them harder and more challenging. The most interesting new formula

(Continued on Page 66)

Professor Grantham of the physics department has made outstanding progress in the humanization of the sciences. During his forty-four year teaching career, he has made the basic physics course a study in scientific thought rather than a dull mass of formula memorization.

NON-TECHNICAL REQUIREMENTS FOR ENGINEERING STUDENTS

by Director Charles C. Winding

Last May Charles C. Winding was named Director of Cornell's School of Chemical and Metallurgical Engineering and successor to the Herbert Fisk Johnson Professorship of Industrial Chemistry.

An authority on rubber, plastics, heat transfer and fluid flow, Director Winding is frequently consulted by industrial firms, including at present Rome Cable Corporation and B. F. Goodrich Company.

He has written a number of technical articles in these fields, is co-author of a book on "Plastics, Theory and Practice," and a contributor to the "Handbook of Engineering Materials."

The need for humanities, social sciences, and the arts in engineering curricula is a subject that has been so belabored in recent years that it approaches the "platitudinous moralizings" designation of Aldous Huxley. Fanaticists have even appeared, such as the scientist who suggested that the neglect of phrenology was an example of incredible narrowness and prejudice. However, one cannot argue with the premise that an engineer is better able to take his place in society if he has an appreciation of the humanities, literature, and the arts. Thus, all that is spoken or written on the subject must be pro; the con side must, perhaps unfortunately, be a void.

A great deal of misdirected effort has been applied to "educating" the engineer in non-technical subjects. The quantitative method is the easy one and, for publicity purposes if for nothing else, many schools have adopted the "equivalency" approach, stating that their engineering curricula contain the equivalent of a certain fraction of an art's curriculum. What curriculum is meant? Is there a specific sequence of courses that will produce a broadly educated student without any original effort on his part beyond the temporary assimilation of subject matter properly regurgitated at examination time? Exactly what courses should be involved? It seems utterly ridiculous that any person ignorant of the physical sciences could today be considered broadly educated—yet this is what is frequently implied when the engineer is compared with "well-educated" non-technical students.

Courses dealing with human behavior, both past and present, might well have a place in any sequence of non-technical courses. However, it could be argued that global meteorology is, and was, one of the greatest forces affecting human behavior. But meteorology is always designated as a technical course. Should the non-technical courses prepare the engineer for retirement and the rarely encountered leisure hours? If so, the fine arts might deserve preference. But here again there are possible technical alternates that might be desirable substitutes. What about botany, floriculture, ornithology, and icthyology? Carried to the extreme, we might insist that the non-technical courses revert to the classics. How far short of outright rebellion would we be if all engineering students were required to take four years of Latin or Greek? Surely there is at least a reasonable doubt that any exact specification of non-technical courses might not achieve a definite objective for a particular student.

Some universities have adopted the Humanities 101, 102, etc. approach, sending 300 to 1,000 engineering underclassmen to a hapless arts professor to "humanize." In rare instances the professor is enough of an actor to interfere with the normal expectance of additional sack time, but all too often the sheer weight of numbers destroys effective communication between the lecturer and student. In addition, how can high quality be maintained? Does the instructor of such a course fail a high percentage of engineers in a course not related to their major interest? In such large courses, are the assistants who do the actual grading competent? Such questions are more than pertinent to technical courses and might be much more so in those encompassing all the broad aspects of human endeavor.

There is another, better concealed, fallacy in this approach. This is the tacit assumption that all engineers have the same needs as

far as broader education is concerned. Without doubt there are certain engineering students who have a real need for more liberal training. After approximately fourteen years of television, a serious approach to literature and composition might be more valuable than many technical subjects. However, experienced class advisors should be consulted about the practical methods of inducing engineering sophomores to submit to an additional courses in English composition with any real prospect of serious study.

The inclusion of a large number of non-technical courses must, of necessity, reduce the number of scientific and technical courses at a time when it is obvious that future developments will make much greater demands on the scientist and the engineer than exists today. There is a real danger of ruining the foundation while we attempt to strengthen the walls. This is particularly true if non-technical courses are required that obviously do not fulfill objectives. Many beginning courses in the humanities are designated as an introduction to later offerings of more substance and cannot, by themselves, create the proper appreciation of the field. The inclusion of a large number of such beginning courses to the exclusion of advanced work in engineering and the sciences is certainly not a solution to the problem of producing more broadly educated engineers.

Some non-technical courses are of direct use to the engineer in his professional work. Literature, composition, public speaking, and subjects dealing with human behavior, both past and present, are such courses. They appear in most engineering curricula and the argument should be confined to a consideration of minimums rather than whether or not they should be required. Some students never achieve a really satisfactory level of performance in these areas, while others have some proficiency when they enter the university, but certainly some work should be required in such "tool" subjects since it would directly benefit the graduate. Perhaps a three-year sequence of such courses might be considered to be a minimum.

When we depart from a consideration of the type of courses mentioned in the previous paragraph, a much greater difficulty is encountered. We must be sure that requirements meet the objectives of offering training to produce professional competence and laying a foundation for the development of desirable social attributes. If the engineering graduate has disciplines that permit him to acquire additional knowledge by self-instruction, whatever the field, then the foundation has been laid, and a major objective of higher education has been achieved. The ability to analyze factual information and reach conclusions is certainly one of these disciplines. Since training in such methods is the basis of most technical instruction, the engineer should be highly skilled in this approach. Perhaps he is too highly skilled and lacks familiarity with the more devious approaches characteristic of some other fields of human endeavor. If these are reasonable conclusions, then the objectives of non-technical instruction might be to acquire familiarity with other fields and to develop the proper habits and skills to make additional learning easy.

These objectives might be reached if a sequence of one non-technical course per term was included through the first three years of an engineering curriculum. These would normally be of the "tool" type mentioned previously, making it easier to motivate interest and effort. In the remaining two years, when the student is much more mature, room should

(Continued on Page 70)

Photo Science

Students in the humanities should be encouraged to take more science courses. In order to accomplish this goal, the courses must place stronger emphasis on the methods of science, their history and development. They must include a good deal of free discussion and encourage students to think rather than require them to substitute values in meaningless equations.

INTELLECTUAL BREADTH OUTSIDE THE CLASSROOM

by Professor Dexter Perkins

Dexter Perkins was about to retire as chairman of the history department at the University of Rochester when Cornell asked him to accept the John L. Senior Professorship of American Civilization. Almost immediately, his course on "The United States as a World Power" began to attract 150 to 200 students per semester. His pithy humor, gentleness, and lack of intellectual snobbism have made him one of the most popular professors on the Cornell campus. Dr. Perkins is widely known for his leadership as president of the Salzburg Seminar in American Studies, in Salzburg, Austria. He is regarded as the foremost authority on the Monroe Doctrine.

What is wanted in the way of intellectual breadth during the years of college? What are some of the values not inherent in engineering training which the prospective engineer should attempt to assimilate in the midst of his training for his profession? They are, principally, these—a sense of the beautiful, an understanding of the economic and political order, a sympathetic conception of the process of social change, an appreciation of the international position of the United States. No doubt this does not exhaust the list of possible additions to technical and professional training, but they will do for the moment.

It is one of the weaknesses of a great university that contacts between faculty and students are less intimate than they are in a small college. They ought to be extended. In the selection of its faculty, a university should choose men who, in addition to being scholars, are infused with a genuine desire to communicate with undergraduates, who are not merely technicians and specialists, but sympathetic guides to young men and women. On the side of the faculty, something has been done through the institution of honors work, and if such work could in any way be reconciled with the rigors of the engineering curriculum, a great gain would result. But part of the responsibility lies with the undergraduates themselves, and particularly with the fraternities. In my own experience, much is to be gained by inviting members of the teaching staff to speak to undergraduate groups on subjects of general interest. Sometimes this is done, but it is not done nearly enough. Were more interest taken in such informal meetings, I am sure that many of the faculty would respond. The matter ought to be systematized, not made a matter of casual and infrequent association.

The schedule of the engineering student, it must be confessed, is an exacting one. But we cannot assume that there is no free time whatsoever. And there are always vacations and holidays which can be used for mental improvement, not merely for relaxation or earning money. After all, nobody can become a cultivated human being unless he wants to be, and if he *does* want to be, he will find a way to set aside a little time for the purpose of broadening himself. There are many public lectures at Cornell which have a generalized as well as a specialized interest; there are concerts (and what better than music as a means of cultivating the aesthetic sense); there are discussion groups on all kinds of subjects. Some of these the student ought to find time to attend. But fully as important is the habit of doing a little reading outside of one's specific field. If you want to understand the American economy, read such a work as J. K. Galbraith's "American Capitalism—A System of Countervailing Powers." If you want to understand the American political system, read such a book as Professor Rossiter's "The American Presidency," or his work on Conservatism. If you want something a little tougher than either, but full of ideas, read Max Lerner's new book "America As A Civilization." These, of course, are only examples. Perhaps the student in a technical field should be fur-

Photo Science

A Cornell education involves more than just study in one's chosen field. Activities and extra-curricular work in Sage Chapel choir or other student organizations enable one to develop a large number of talents.

nished at the beginning of his course with a brief list of readings which would enlarge his horizon. Such a list would not be difficult to compile, and it might be invaluable.

The student can appreciate the scope and depth of the activities of Cornell University only by savoring them. The opportunities are all around him; the University Calendar, which he should read religiously each week, will tell him what there is in the way of extra-curricular activity; and the judgments of his fellow-students will tell him who the great teachers in every field are, and whom, therefore, it might be profitable to go and listen to from time to time. If he sincerely desires education in breadth as well as in depth, there is every reason why he should get it here at Cornell.

The impulse to the broad view of life has to come from the individual. Without eagerness to grow in wisdom, there is not much chance of growing. But the question is always open as to whether a given technical program (and I express no opinion on any special program) is so exacting as to leave inadequate time for any broader intellectual activities. This is a question, which in part at least, will be settled only as students desire to see it settled, and make their desires known. But there are no obstacles that I know of to using the University, except that of time, and I suspect even this is not so serious a matter as is sometimes assumed.

When it comes to the weaknesses and advantages of Cornell, they are not particularly different from the weaknesses and advantages of the large university in general. A great many of the values of education lie in highly personalized instruction, and highly personalized instruction is difficult in an institution with thousands of students. It is probable, too, that there are more distractions in such an institution than in a smaller one, and the only answer to the problem lies in the careful exercise of individual judgment by the student himself. On the other hand, he may be sure that he will, in general, be better taught, by more eminent men, than he will be at a small college. There are exceptions to the rule, but they do not vitiate the rule.

In summary, I should say that the student who wishes to combine liberal with technical education must first define what he means by liberal education, as I have tried to at the beginning of this article; that he must make an effort to get into contact with devoted and wise teachers in the liberal studies; that he must do some reading in these various fields, and attend some of the extra-curricular offerings; and that, if he feels that the demands on his time exclude any possibility of doing these things, he should make his views felt. For Cornell is dedicated to liberal education, and its teachers in every field recognize the responsibility that this entails.

HOLLISTER

(Continued from Page 19)

A few years ago the president of a sister institution stated that in the liberal arts, and only in the liberal arts, would one find the means of development in *both* conscience and competence. Competence, he asserted, might be advanced through professional education, but not conscience. It would be difficult to find better means for the development of intellectual honesty than training in the sciences and their applied counterparts. Assertions such as he made are usually from persons who have not undergone such rigorous intellectual discipline as the sciences impose.

The art of living, properly fulfilled, includes the development of those aesthetic manifestations of thought and action that may be spoken of as culture. The humanities and classics are often cited as the ideal—even to some, exclusive media for the acquisition of culture. But the sciences, likewise, both pure and applied, offer wonderful opportunities for such transfer. In the last analysis, it is the instructor, rather than his subject that may make the greatest contribution to the cultivation of a cultured life.

The training of the liberal man in four years is still being attempted in this country. In European countries the earlier education is very rich in material essential to a balanced program. In this country the elementary and high school programs are not as rigorous, do not develop the degree of intellectual discipline nor provide the

same body of knowledge as in the elementary and secondary European schools. To achieve the combined objectives, four years is obviously not enough. Nor is it sufficient to assume that the objectives of higher education beyond the professional requirements can be satisfied by the simple process of taking a B.A. degree. One must examine the composition of the program as a balanced program, one in which the objectives above stated are actually met.

The limitation on time available for formal education places great emphasis upon the training for self-education. No college program can with propriety dodge the necessity of this objective. It is unfortunate that many people approach a college course with the idea that once taken, they have acquired thereby, a complete education.

McMANUS

(Continued from Page 26)

to give leadership to the spreading complex of human affairs, he must first be able to act competently in the technological responsibilities that society expects him to carry out.

This is not to say that professional competence and intellectual breadth are incompatible—indeed there can be no doubt that they are complementary. Engineering education must insure the first and stimulate the second. The achievement of both aspects can come in part from the plan of a curriculum, but the ultimate essential ingredient lies within the student himself. Fortunately the engineer is, by nature, imaginative and curious. These qualities, necessary for his professional development, are also those which make him receptive to the whole range of intellectual and cultural appreciation.

The engineer finds his ultimate satisfaction not in the blind proliferation of technical knowledge but in its utilization with judgment and reasoning for the benefit of society. The achievement of this attitude among engineering students is the challenge and the promise before engineering educators and their colleagues in the humanities.

MALOTT

(Continued from Page 18)

eventually at the end—but like the marble going downhill all the way.

A considerable volume of correspondence comes to me from recent graduates of Cornell. As a member of the class of 1956 recently wrote me:

> "If our country has anything of permanent value to contribute to our present world and to future generations, it is not our techniques of mass production nor our advertising know-how nor our ability to make bigger and better bombs and missiles. It is rather our system of democratic government, based perhaps for the first time in all history on the freedom and inviolability of spirit of the common man, and upon his ability to rule, through elected representatives, a total society. No system save democracy, and no country so much as America, can claim to have given so great freedom within law and so great economic, political, social and religious opportunity to its people."

The future leadership must come from those emerging from our colleges and universities. It will come chiefly from those who have achieved that breadth of education which is firmly based, not upon professional training only, but upon those basic disciplines in the humanities, the social sciences, the biological as well as the physical sciences, so essential to one's understanding of life.

I can only hope that you in the College of Engineering will become not only thoroughly grounded in the engineering discipline of your selection, but that you will learn also of the accumulated knowledge of our cultural past, of our human achievements, of the long process by which we have arrived at both the soberness and the hullabaloo of the atomic age. I hope, too, that you will be aware of the difference between right and wrong, of that infinite chasm which differentiates liberty from bondage—that bondage which lies like a great miasma between the stanchions of the iron and the bamboo curtains. Thus will you have attained the objectives which Cornell has for you—a whole person ready for leadership in the restless years that lie ahead.

Cornell University, with its wide range of intellectual activities, offers students the opportunity to broaden their backgrounds. The White Art Museum provides guided tours of their exhibits. The wide variety of artistic exhibits provide a chance for cultural development which should not be missed.

Photo Science

CAN YOU FIGURE IT OUT?

Problem: Determine the digits represented by dots in the multiplication example at the right.

```
  .1...
x  417
-------
  ..... .
   ....  .
  ....  .
-------
 9...057
```

*Solution at bottom of page

Robert A. Pike tells what it's like to be . . . and why he likes being . . . a Research Physicist with IBM.

FIGURING OUT A CAREER?

Selecting a career can be puzzling, too. Here's how Bob Pike found the solution to *his* career problem—at IBM:

"I became interested in computers and transistors at college," Bob Pike recalls. "Upon graduation, I naturally turned to the computer field. IBM, as a leader in the field, looked like a good place for me." After a training period, he joined the Semi-Conductor Device Development Group in Research. Promoted to Associate Physicist soon afterward, his present assignment is leading a group of technicians in fabricating high-frequency, high-power PNP dr'ft transistors. "These will be used as core drivers in a high-speed memory array," he says. His future? At the rate IBM and the electronic computer field are expanding, Bob Pike foresees excellent opportunity for advancement in the area of his choice.

• • • •

There are many excellent opportunities for well-qualified engineers, physicists and mathematicians in IBM Research, Development and Manufacturing Engineering. Why not ask your College Placement Director when IBM will next interview on your campus? Or, for information about how your degree will fit you for an IBM career,

JUST WRITE TO:

Mr. R. A. Whitehorne
IBM Corp., Dept. 854
590 Madison Avenue
New York 22, N. Y.

***SOLUTION**

Let the multiplicand be $D1CBA$. Since the units digit in the answer is 7, the only value possible for A is 1. This also fixes one of the dots in the hundreds column as a 1; to get a 5 in the answer, the other dot must be a 4. Hence B can only be a 2. Similar reasoning will determine C as 9 and D as 2. Answer = 21921.

IBM INTERNATIONAL BUSINESS MACHINES CORPORATION

DATA PROCESSING
ELECTRIC TYPEWRITERS
MILITARY PRODUCTS
SPECIAL ENGINEERING PRODUCTS
SUPPLIES
TIME EQUIPMENT

JOB FACTS FROM DU PONT

DU PONT

BETTER THINGS FOR BETTER LIVING
THROUGH CHEMISTRY

LIBERAL EMPLOYEE BENEFIT PROGRAM AT DU PONT INCLUDES INSURANCE, SAVINGS AND STOCK PLANS

WHAT'S YOUR LINE? DU PONT NEEDS ALL KINDS OF ENGINEERS

Du Pont has always needed chemists and chemical engineers, and still does. But today, there's critical need for engineers in almost every other field—civil, mechanical, electrical, instrumental and industrial engineering, to name a few.

Expansion is the major reason. In 1957, for example, sales at Du Pont were nearly two billion dollars. Four new plants were being built. New research programs were being launched. New products were moving into the production and marketing stages. Engineers and scientists of all kinds work in 75 Du Pont plants and 98 laboratories in 26 states. All of this tends to broaden opportunities for the young scientist and engineer at Du Pont.

If you're interested in finding full scope for your ability, and this includes a great many special fields, Du Pont offers you plenty of opportunity to move ahead.

SEND FOR INFORMATION BOOKLET ON JOB OPPORTUNITIES AT DU PONT

Booklets on jobs at Du Pont are yours for the asking. Subjects covered include: mechanical, civil, metallurgical, chemical, electrical, instrumentation and industrial engineers; atomic energy, technical sales, business administration, research and development. Name the subject that interests you in a letter to Du Pont, 2494-F Nemours Building, Wilmington 98, Del.

PERSONALIZED TRAINING

by
H. J. Hollberg
Du Pont
Representative

When you join Du Pont as a scientist or engineer, you're given an actual project assignment almost at once and begin to learn your job by doing it. That's the essence of our training philosophy at Du Pont.

Our objective is to give you responsibility at the outset and qualify you quickly for more, because the more we grow, the more we need trained leaders.

Although there is no one training program at Du Pont (each of our many departments runs its own), all have several basic features in common. All are personalized—tailored to the new man's background and interests. All involve close supervision on an informal, day-to-day basis. And all permit periodic evaluation of the new man.

This flexible system helps the new man to move ahead according to his abilities. He gets to know Du Pont and his job quickly. He gets a head-start on future responsibility.

You probably have questions about this program and how you'd fit into it. I'll be glad to try to answer them when I visit your campus. Why not sign up for a Du Pont interview at your placement office now?

Means More Security, Greater Real Income To Young Graduates

Du Pont believes that the employee builds his own job security by the way he does his work, by his contributions to the progress of the Company and by his readiness to accept responsibility.

But Du Pont meets the employee more than halfway with a program of benefits designed to help him as he advances.

Your employee benefits go to work the day you join the Company. They grow and build equity for you as the years go by. Vacations, life insurance, group hospital and surgical coverage, accident and health insurance, pension and bonus plans are all part of the program.

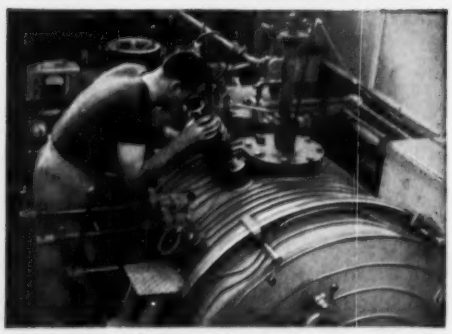
Let's look at a special example, the Thrift Plan. You become eligible for it after one year with the Company. For each dollar you invest in U. S. Savings Bonds, the Company contributes twenty-five cents toward the purchase of Du Pont common stock in your name. Roughly 65 per cent of the Company's 90,000 employees are now participating in the plan.

When you're deciding on a career, security is only one consideration. But it's an important one to you and your family. At Du Pont, security is a bright part of the future awaiting the college graduate.

★ ★ ★

More than 700 of the some 1100 degree-granting colleges and universities in the U. S. are represented at Du Pont. Of these 700, more than half are the smaller liberal arts colleges.

What's doing....



Vacuum melting has opened up new horizons for development of alloys. Here, a Pratt & Whitney Aircraft metallurgist is shown as he supervises preparation of an experimental high-strength nickel-base alloy, melted and cast under high vacuum.

Induction melted heat of high-temperature alloy being poured in P & W A's experimental foundry. Molten metal is strained into large water tank, forming metal shot which is remelted and cast into test specimens and experimental parts. Development and evaluation of improved high-temperature alloys for advanced jet engines is one of the challenges facing metallurgists at P & W A.

at Pratt & Whitney Aircraft in the field of Materials Engineering

The development of more advanced, far more powerful aircraft engines depends to a high degree on the development of new and improved materials and methods of processing them. Such materials and methods, of course, are particularly important in the nuclear field.

At Pratt & Whitney Aircraft, the physical, metallurgical, chemical and mechanical properties of each new material are studied in minute detail, compared with properties of known materials, then carefully analyzed and evaluated according to their potential usefulness in aircraft engine application.

The nuclear physics of reactor materials as well as penetration and effects of radiation on matter are important aspects of the nuclear reactor program now under way at P & W A. Stress analysis by strain gage and X-ray diffraction is another notable phase of investigation.

In the metallurgical field, materials work involves studies of corrosion resistance, high-temperature mechanical and physical properties of metals and alloys, and fabrication techniques.

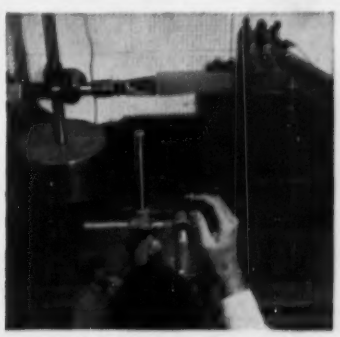
Mechanical-testing work delves into design and supervision of test equipment to evaluate fatigue, wear, and elevated-temperature strength of materials. It also involves determination of the influence of part design on these properties.

In the field of chemistry, investigations are made of fuels, high-temperature lubricants, elastomeric compounds, electro-chemical and organic coatings. Inorganic substances, too, must be prepared and their properties determined.

While materials engineering assignments, themselves, involve different types of engineering talent, the field is only one of a broadly diversified engineering program at Pratt & Whitney Aircraft. That program — with other far-reaching activities in the fields of mechanical design, aerodynamics, combustion and instrumentation — spells out a gratifying future for many of today's engineering students.

Engineer measures residual stress in a compressor blade non-destructively, using X-ray diffraction. Stress analysis plays important part in developing advanced aircraft engine designs.

The important effects of gases on the properties of metals have been increasingly recognized. Pratt & Whitney chemists are shown setting up apparatus to determine gas content of materials such as titanium alloys.



P & W A engineer uses air jet to vibrate compressor blade at its natural frequency, measuring amplitude with a cathetometer. Similar fatigue tests use electromagnetic excitation.

Pratt & Whitney Aircraft operates a completely self-contained engineering facility in East Hartford, Connecticut, and is now building a similar facility in Palm Beach County, Florida. For further information about engineering careers at Pratt & Whitney Aircraft, write to Mr. F. W. Powers, Engineering Department.

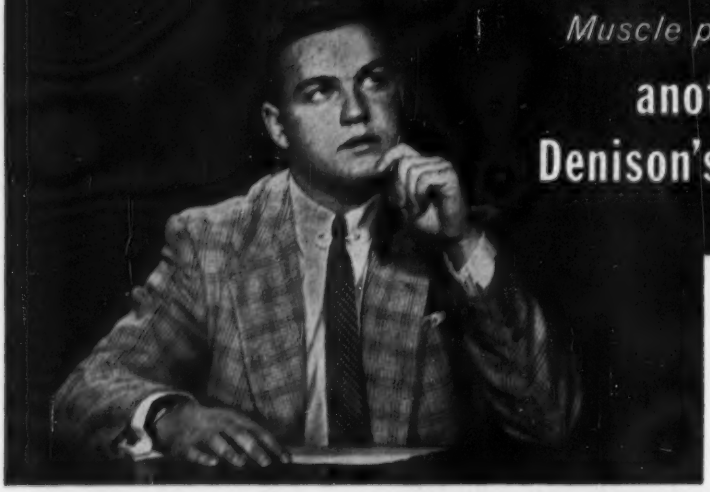
World's foremost designer and builder of aircraft engines

PRATT & WHITNEY AIRCRAFT

Division of United Aircraft Corporation

EAST HARTFORD 8, CONNECTICUT

HYDRAULICS IN YOUR FUTURE



Muscle power for a ghost engine...

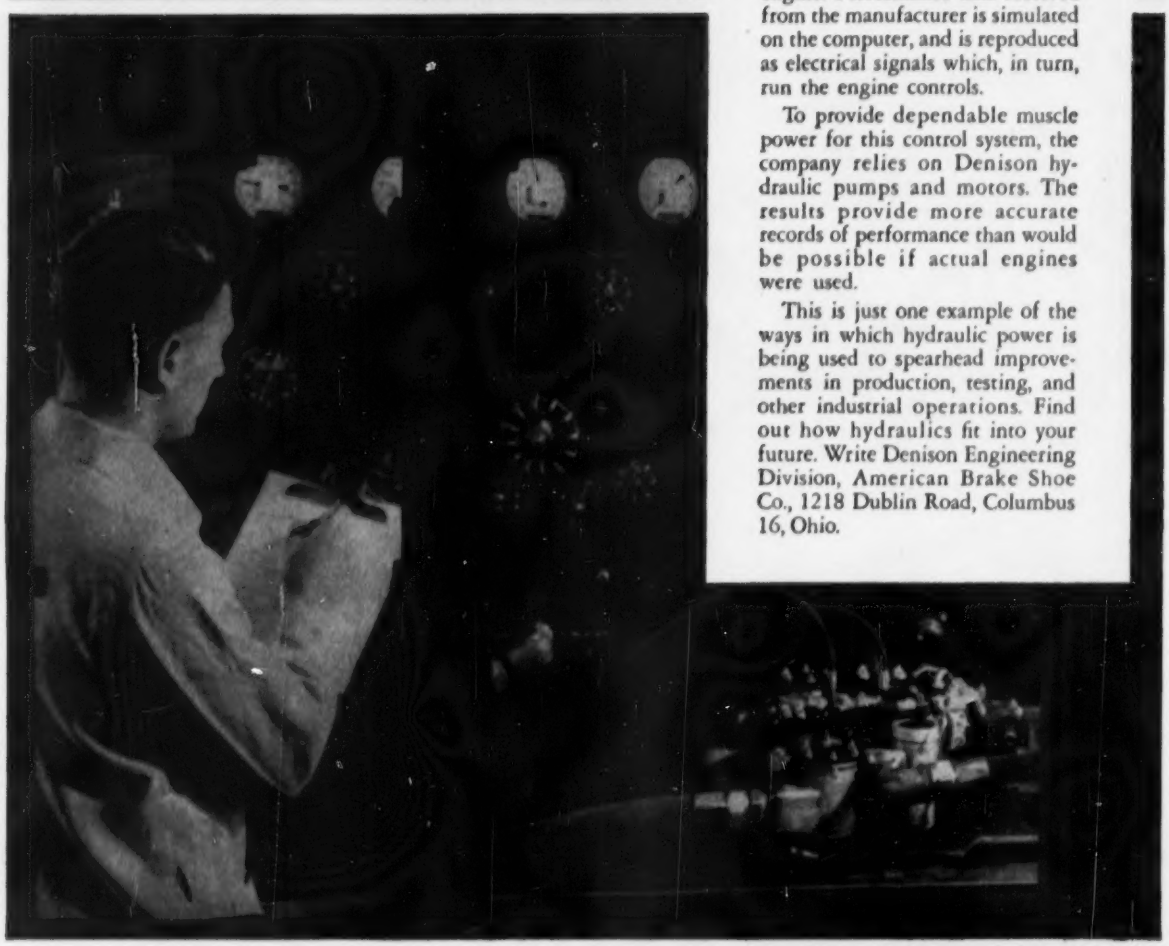
another example of Denison's hydraulic ingenuity

A UNIQUE ELECTRONIC SYSTEM developed to pre-test jet engine controls now eliminates the cost of building and operating a special engine test cell.

In the system, an analog computer takes the place of the jet engine. Performance data received from the manufacturer is simulated on the computer, and is reproduced as electrical signals which, in turn, run the engine controls.

To provide dependable muscle power for this control system, the company relies on Denison hydraulic pumps and motors. The results provide more accurate records of performance than would be possible if actual engines were used.

This is just one example of the ways in which hydraulic power is being used to spearhead improvements in production, testing, and other industrial operations. Find out how hydraulics fit into your future. Write Denison Engineering Division, American Brake Shoe Co., 1218 Dublin Road, Columbus 16, Ohio.



Look to **DENISON** *for leadership in hydraulic development*

DENISON HydrOILics

RCA ELECTRONICS KEEPS A RADAR "WEATHER EYE" ON YOUR COMFORT ON THE GREAT AIRLINES

Flying into a starless night, the pilot's vision may reach a mere 50 yards. Yet he sees a storm brewing 150 miles ahead.

Within minutes he plots a slight change in course and flies a smooth, safe corridor *through* the weather. His passengers complete their trip in comfort and on schedule.

Credit RCA Electronics for the "Weather Eye" radar that makes all this possible. And United Air Lines' all-radar fleet for being the first (among 24 leading airlines) to use this important development.

RCA pioneering also produced radar that guides ships at sea and tracks man-made satellites through space. RCA pioneered color television, produced the world's largest electronic computer, peanut-sized transistors and much, much more.

Progress like this helps explain why RCA *means* electronics – and why electronics means a happier, healthier, more secure future for you.

RADIO CORPORATION OF AMERICA

WHERE TO, MR. ENGINEER?

RCA offers careers in TV and allied fields—in research, development, design and manufacturing—for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. Join the RCA family.

For full information write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, New Jersey.

CORNELL SOCIETY OF ENGINEERS

107 EAST 48TH STREET 1957-58 NEW YORK 17, N.Y.

ROSCOE H. FULLER, M.E. '24 ..... *President*
17 Elm Street, Morristown, N.J.

DANIEL M. LAZAR, C.E. '29 ..... *Executive Vice-President*
30 Vesey Street, New York 7, N.Y.

STEPHEN D. TEETOR, C.E. '43 ..... *Secretary-Treasurer*
101 Park Avenue, New York 17, N.Y.

ELLIOTT R. THOMPSON, M.E. '24 ..... *Recording Secretary*
Baldwin-Hill Co., Trenton 8, N.J.

Regional Vice-Presidents:

Delaware Valley:
JAMES W. JOHNSTONE, JR. ..... 1700 Sansom Street, Philadelphia 3, Pa.

New England:
GERALD S. WHITE ..... 231 Washington Street, Belmont 78, Mass.

Chicago:
FRED M. GILLIES ..... Acme Steel Co., Chicago 27, Ill.

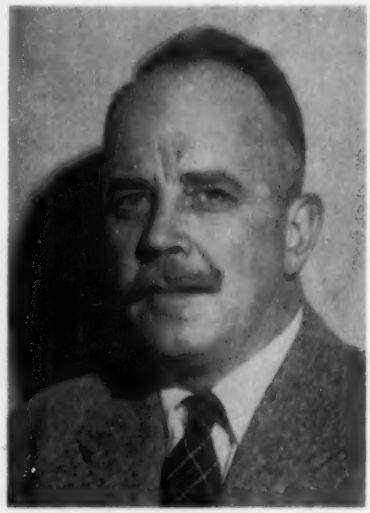
Detroit:
L. IRVING WOOLSON ..... P.O. Box 1628, Detroit 31, Mich.

St. Louis:
FRED HUME ..... 4931 Lindell Boulevard, St. Louis 8, Mo.

Honorary President: S. C. Hollister, Dean, College of Engineering

Honorary Vice-Presidents:
C. C. Winding, Director, School of Chemical and Metallurgical Engineering
H. J. Loberg, Director, Sibley School of Mechanical Engineering
N. A. Christensen, Director, School of Civil Engineering
W. H. Erickson, Director, School of Electrical Engineering
T. R. Cuykendall, Director, Department of Engineering Physics
W. R. Sears, Director, Graduate School of Aeronautical Engineering

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationship between the College and its alumni."



Roscoe H. Fuller

THE PRESIDENT'S MESSAGE—

The Purpose of Reports

Most of us have from time to time been called upon to evaluate an engineering report, and a great majority of us have had to write them. What constitutes a good report?

We take for granted the technical competence of the person reporting, since such competence or the lack of it is immediately obvious. Beyond this, the difference between a good report and a poor one lies in that unassignable feeling of satisfaction received by the reader. This is only partly a matter of presentation, although presentation is important. (Fifth Avenue fashions attract more favorable attention than a Mother Hubbard.)

What is often overlooked in preparing a report is the object behind it. Most usually a report is requested or initiated for the purpose of arriving at or prompting a decision. Too often the report is merely factual, presenting the results of an investigation of some sort without comment or recommendation. Such a report sidesteps what is usually its principal objective.

The person or agency receiving a report, whether one dealing with government operations on a large scale or one limited to a small segment of operations or research of limited applicability is usually burdened with administrative responsibility, and is frequently unable to evaluate a mass of purely factual data. Whether this inability results from lack of time, lack of inclination or lack of competence is not germane. The point is that a report which merely sets forth data, however diligently prepared or attractively presented, is only half done.

The important half, and the half which makes the difference between a good and a poor report; the half which does the business, in other words, is that covering conclusions and recommendations for action. The authority to which a report is presented, having entrusted its preparation to hands in which it has confidence, has a right to expect that the person preparing it will analyze the data set forth and will be competent to reach conclusions based thereon.

Having reached a logical conclusion, the setting forth of recommendations for a plan of action not only saves the time of the recipient, but lessens the likelihood of the report being filed away without further result. And since the principal object of a report is to provide a basis for action, the end to be served is best attained by a logical, forceful and unmistakable set of recommendations.

Roscoe H. Fuller

ALUMNI ENGINEERS

Clifton H. Ewing, EE '28, who has been an instructor at Western New England College, Springfield, Mass., since 1947, has been appointed dean of the school of engineering and professor of engineering there. Dr. Ewing is the possessor of four degrees and previously was an instructor at Cornell. He was formerly project engineer with New York Telephone Corp. and Westinghouse.

Asa George, CE '36, executive engineer and assistant secretary of the Power Authority of the State of New York, is engaged in the many phases of planning, design, and construction of the 600,000,000-dollar international St. Lawrence River Power Project scheduled to be completed in 1959.

Duncan B. Williams, ME '24, has been appointed general sales manager of Union Carbide Olefins Co., division of Union Carbide Corp. He joined Union Carbide in 1924 as an oxygen column operator for the Linde Co. He transferred to Union Carbon Chemicals Co. in 1925 as a field manager in Tulsa, Okla. In 1926, Mr. Williams came to New York City as sales engineer in which capacity he was concerned with sales development of Pryofax Gas, Chlorex Selective Solvent, and Carboseal Anti-Leak. In 1938, he was appointed manager of the special products departments concerned with sales of Ucon Synthetic Lubricants.

Alumni News

Duncan B. Williams

William Littlewood, ME '20, has been recently elected an Honorary Fellow of the Institute of the Aeronautical Sciences, for his outstanding record of achievement in the aeronautical industry. Mr. Littlewood, at present Vice President-Equipment Research, American Airlines, Inc., is recognized as a leading air transport engineer and has made basic contributions to many widely used commercial aircraft. He has had a hand in the development of the Convair series, the DC-3, DC-4, DC-6, and the DC-7, as well as in the specifications and selection of the Lockheed Electra and Boeing 707 for future airline equipment.

He first entered the aviation industry in 1927 with Fairchild Aircraft where he became General Manager (before joining American Airways in 1930). When this firm was reorganized in 1934 to American Airlines, he remained, becoming Chief Engineer three years later.

A past president of the SAE, Mr. Littlewood has also served several terms as vice-president of the society and the IAS. For ten years he was a member of the NACA Subcommittee on Aircraft Noise, which he helped to form six years ago. He is a member of the NACA Industry Consulting Committee and the ATA Engineering Committee and is Chairman of the joint committee on the development of Proximity Warning and Collision Preventing Systems. He also serves as Chairman, Advisory Panel on Aeronautics, Office of the Assistant Secretary of Defence (Research and Engineering).

Mr. Littlewood is past president of the Cornell Society of Engineers, A Director of the Cornell Aeronautical Laboratories, and has served several terms as a Director of the Cornell Alumni Association.

Gaston R. Desnoyers, ME '44, of Plainfield, N.J., has been promoted to section head of cost estimating in the Esso engineering department of Esso Research & Engineering Co.

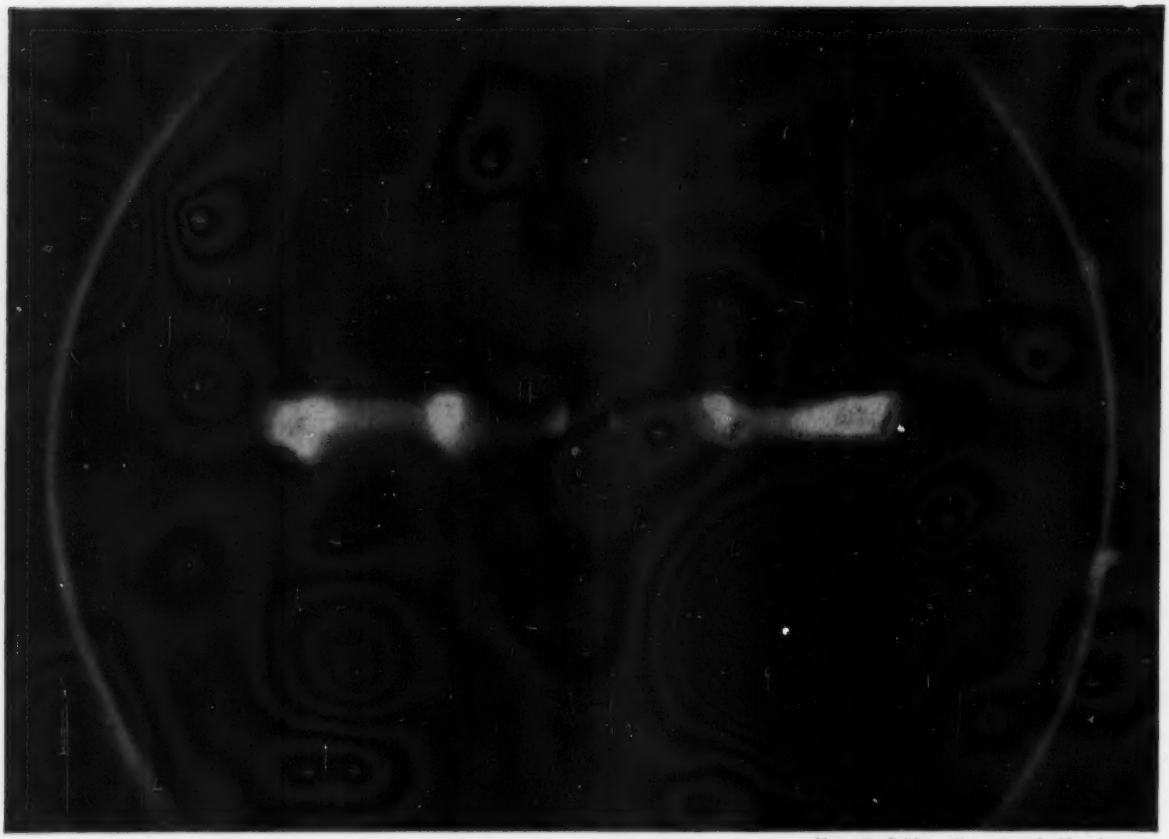
Alumni News

William A. Gay

William A. Gay, ChE '40, has been appointed production superintendent at the Bound Brook, N.J. plant of Bakelite Co., division of Union Carbide Corp. He has been with the company since 1940 except for service as a captain of field artillery in Europe during World War II.

Austin H. Church, ME '28, professor and chairman of mechanical engineering department at New York University, is on an industrial leave of absence for the current academic year, working for General Electric in Schenectady. He has written several books, including Centrifugal Pumps and Blowers, Wiley, 1944; Elementary Mechanical Vibrations, Pitman, 1948; Kinematics of Machines (with G. Guillet), Wiley, 1950; and Mechanical Vibrations, Wiley, 1957.

Edwin L. Harder, EE '26, is director of the analytical department of the Westinghouse Electric Corp. in East Pittsburgh, Pa. Mr. Harder has been with Westinghouse since 1926 and has been the author of more than 100 technical papers as well as being the holder of more than fifty US patents. In December, he addressed a joint meeting of the engineering and technical societies of the Ithaca-Elmira area on the subject: "The Coming Revolution in Computers."



Magnetic fields, acting as a double piston, drive luminous ionized shock waves through transparent tube. One-tenth microsecond exposure in STL's Physical Research Laboratory.

MAGNETOHYDRODYNAMICS and SPACE TECHNOLOGY

Magnetohydrodynamics provides one of the most promising approaches for attaining the velocities and specific impulses that will be required for manned space flight to a planet, landing, and returning.

The critical problem in attaining velocities of hundreds of thousands of miles per hour is the containment of temperatures comparable to those in the interior of stars. Because the temperature of the driving reaction will have to rise as the square of the exhaust velocity, temperatures greater than one million degrees will be encountered in reaction chambers. Magnetohydrodynamics offers a unique solution to the basic problem of containing the reaction without contact with the chamber walls.

Briefly, the physical principles of magnetohydrodynamics are these. Since gas at such temperatures is completely ionized and is an effective conductor of electricity, the introduction of currents in the gas (in this state called a plasma) creates an electromagnetic field. This field makes it possible to control the plasma by applying an external opposing magnetic field which creates a magnetic bottle to contain the charged gas particles. Similarly, a magnetic-field piston can be used to accelerate the particles. Such magnetohydrodynamic reactions are expected to develop exhaust velocities that are an order of magnitude greater than those generated by present chemical rockets.

At Space Technology Laboratories, both analytical and laboratory work are proceeding in the field of magnetohydrodynamics. This work illustrates the advanced research in STL's Physical Research Laboratory, which emphasizes the application of basic physical principles to the requirements of space technology.

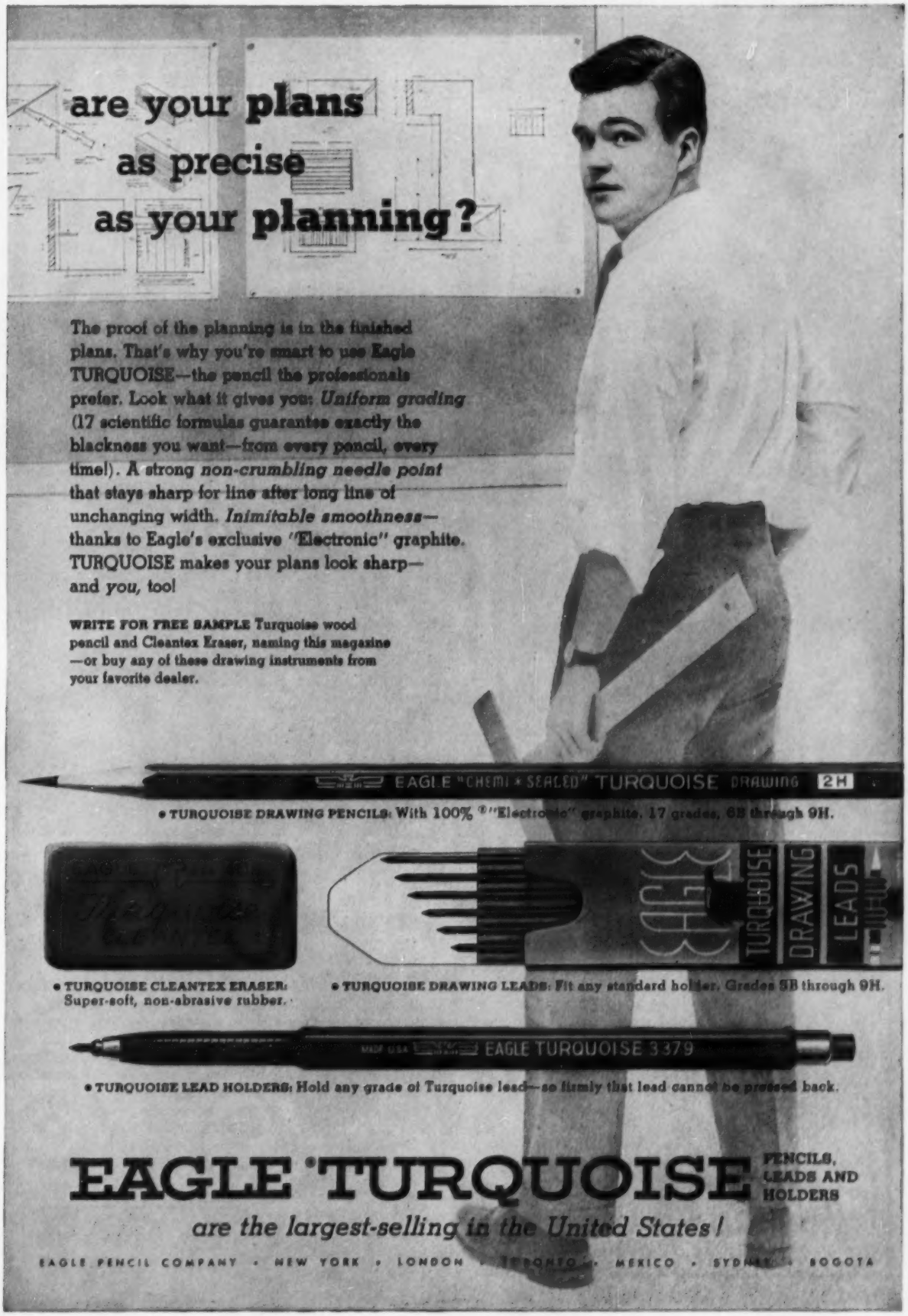
In support of its over-all systems engineering responsibility for the Air Force Ballistic Missile programs, and in anticipation of future system requirements, STL is engaged in a wide variety of research and experimental development activity. Projects are in progress in electronics, aerodynamics, propulsion, and structures.

The scope of work at Space Technology Laboratories requires a staff of unusual technical breadth and competence. Inquiries regarding the many opportunities on the Technical Staff are invited.

SPACE TECHNOLOGY LABORATORIES

A Division of The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA


are your plans
as precise
as your planning?
The proof of the planning is in the finished plans. That's why you're smart to use Eagle TURQUOISE—the pencil the professionals prefer. Look what it gives you: *Uniform grading* (17 scientific formulas guarantee exactly the blackness you want—from every pencil, every time!). A strong *non-crumbling needle point* that stays sharp for line after long line of unchanging width. *Inimitable smoothness*—thanks to Eagle's exclusive "Electronic" graphite. TURQUOISE makes your plans look sharp—and *you*, too!
WRITE FOR FREE SAMPLE Turquoise wood pencil and Cleantex Eraser, naming this magazine —or buy any of these drawing instruments from your favorite dealer.
EAGLE "CHEMI-SEALED" TURQUOISE DRAWING 2H
• TURQUOISE DRAWING PENCILS: With 100% "Electronic" graphite. 17 grades, 6B through 9H.
• TURQUOISE CLEANTEX ERASER: Super-soft, non-abrasive rubber.
EAGLE TURQUOISE DRAWING LEADS
• TURQUOISE DRAWING LEADS: Fit any standard holder. Grades 5B through 9H.
EAGLE TURQUOISE 3379
• TURQUOISE LEAD HOLDERS: Hold any grade of Turquoise lead—so firmly that lead cannot be pressed back.
EAGLE TURQUOISE
PENCILS, LEADS AND HOLDERS
are the largest-selling in the United States!
EAGLE PENCIL COMPANY • NEW YORK • LONDON • TORONTO • MEXICO • SYDNEY • BOGOTA

Readin', 'Ritin', and Reliability

Synthane plastic laminated bushings and breaker arms for automotive ignition.

Dependable operation of a school bus, a truck, or your own car involves the functioning of many parts. One breakdown can wipe out the memory of ten thousand trouble-free miles.

Some of these parts are made of laminated plastics. They're usually unseen, unsung, small in size yet efficiently performing their job.

Their cost is relatively insignificant when compared with the cost of equipment in which they work, but it should be sufficient to insure dependability.

Actually, what you pay for Synthane laminated plastics is little or no more than you'd pay for any other plastic laminate. But the Synthane price includes top quality materials, product control, excellent facilities and workmanship, an assurance of continuous supply, and a long reputation for fair dealing.

If you are interested in a reliable source of laminated plastics—sheets, rods, tubes, or completely fabricated parts, write for an interesting catalog or call our representative nearest you.

SYNTHANE

SYNTHANE CORPOATION, 13 RIVER RD., OAKS, PA.

NUMBER TWO IN A SERIES
ON MARQUARDT MANAGEMENT

Marquardt Means Opportunity

Every day, young engineers are finding opportunity at Marquardt—and for good reason! Marquardt grew and still grows on a foundation of engineering skill—guided by an engineer-management with an engineer-philosophy. Engineers are key men at Marquardt. And because engineers are key men, their work and accomplishments are readily recognized and rewarded.

If you are an engineer, physicist, or mathematician with ability to meet and conquer supersonic and hypersonic propulsion and controls projects, you'll want to investigate the opportunities at Marquardt, the leader in ramjets—"Powerplant of the Future".

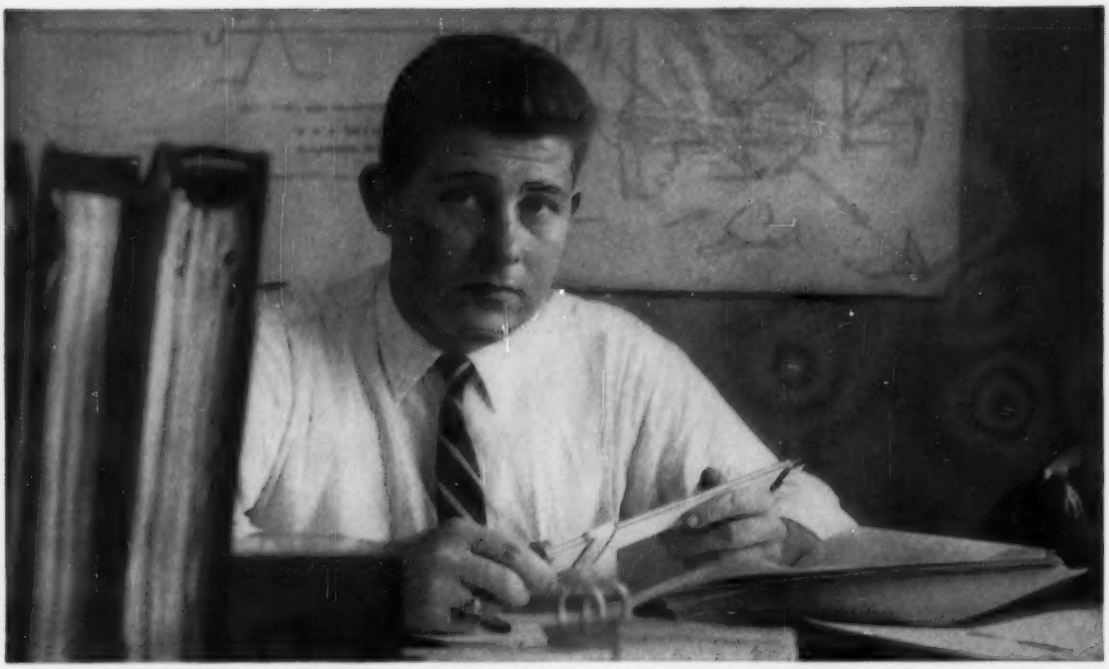
Meet the Marquardt representatives when they visit your campus. See your placement director for further information and exact dates, or write to Dock Black, Professional Personnel, Marquardt Aircraft, 16555 Saticoy Street, Van Nuys, Calif.

Don Walter, B.S.M.S., achieved an outstanding academic record at Cal Tech, Class of '40, while earning seven varsity letters. Today as Vice President in charge of Engineering and Van Nuys Operations, Don utilizes his technical and teamwork background to lead Marquardt's engineering and development manufacturing.

marquardt AIRCRAFT CO.

Van Nuys, California
Ogden, Utah

FIRST IN RAMJETS



John Lawlor, B.S. in E.E., Brown, '52, answers some questions about

An engineering career with the Bell Telephone Companies

John Lawlor is a Transmission Engineer with New England Telephone and Telegraph Company in Boston. His answers reflect his experiences during five years in the telephone business.

Q ***How did you begin as an engineer in the Bell Telephone Companies?***

A My first fifteen months were spent in "on-the-job" training—changing assignments every three months or so. These assignments gave me a broad, over-all background in telephone engineering. And they were accompanied by plenty of responsibility. They progressed in importance with my ability to handle them.

Q ***What is the attitude of older engineers and supervisors toward young men?***

A I've found a strong team spirit in the telephone company. You're encouraged to contribute your ideas, and they're received with an open mind. Young men and new ideas are regarded as vital to the continuing growth of the company.

Q ***How about opportunities for advancement?***

A I'd say they depend on the man. Opportunities to demonstrate your ability come with each new job you're given. The size and importance of your assignments grow with your ability to handle them. All promotions are made from within, and the growth of the business is creating new openings all the time. One more thing. Most telephone engineering locations are convenient to colleges. You can aid your advancement by keeping on with your studies.

Q ***How does the telephone company stack up where pay is concerned?***

A Starting salaries are competitive with those offered by most large companies. Raises are based on merit, with several increases during your first two years with the company. What's more, your performance is reviewed regularly to make sure that your pay keeps up with your progress. All things considered, I think a Bell Telephone career is second to none in rewards and opportunities.

• • • •

Find out about career opportunities for *you* in the Bell Telephone Companies. Talk with the Bell interviewer when he visits your campus. And read the Bell Telephone booklet on file in your Placement Office, or write for "Challenge and Opportunity" to: College Employment Supervisor, American Telephone and Telegraph Company, 195 Broadway, New York 7, N. Y.

BELL TELEPHONE COMPANIES

Cornell's newest graduate degree:

PROFESSIONAL MASTERS DEGREE

The College of Engineering is awarding a new graduate degree, the Professional Masters degree, to students completing a minimum of forty-five credit hours of course work in advanced science theory and engineering application. The professional degree is a terminal program for the engineer in industry who does not wish to pursue graduate work on a higher level than the masters degree. The curriculum is composed of a core of advanced subjects, such as mathematics, physics and chemistry and specialized topics within an engineering area. There is no written thesis.

Each engineering school within the College plans its own basic curriculum. In his general field, the student may elect one of the several specialized training sequences or adopt a modification of the options to suit his particular needs and interests. The schools offer the following degrees: Master of Civil Engineering, Master of Mechanical Engineering, Master of Electrical Engineering, Master of Chemical Engineering, Master of Metallurgical Engineering and Master of Industrial Engineering.

The reasons for the professional degree have grown out of the needs of the engineer in industry. He finds that technology has taken such rapid strides forward that it is almost impossible to acquire a working knowledge of the newest advances in his own field and of the fields that are just opening and expanding. Such fields as transistors, operations research, computors and nuclear engineering require study beyond the undergraduate level if they are to competently understand and used. Since many of these new areas depend heavily upon basic scientific discoveries, many engineers also find themselves with an inadequate background in the sciences. If the engineer elects to do graduate work, he finds that the objective of the general master of science degree is research. This does not always coincide with objectives of the engineer in industry. He wants a route for professional advancement within his engineering specialty. The professional degree, with its planned sequence of science courses and technical options, provides this opportunity.

Although the professional masters program does not require a written thesis, "it is by no means an easier route to a graduate degree," emphasized John McManus, assistant dean of the College of Engineering and a member of the Graduate Committee in Engineering. The requirements for admission into candidacy for this degree are essentially the same as those for the general degree of the Graduate School. Specifically, the applicant must hold a baccalaureate or equivalent degree from a college of recognized standing in a field of engineering or science and must show promise of ability satisfactory to pursue advanced study. To qualify for a degree, the candidate must satisfactorily complete at least forty-five credit hours of advanced technical courses or their equivalent, except in Chemical and Metallurgical Engineering, where 54 credit hours are required. The required number of credit hours may be reduced in special cases to no less than thirty by allowing credit for advanced work completed before entrance into the program. Professional experience may be given credit if the hours earned in this way, plus the allowance for advanced work completed before entrance into the program does not exceed fifteen hours.

Cornell undergraduate engineering students may be admitted to the program at the beginning of their fifth year. Some of the fifth year subjects carry graduate credit, and fifth year students can take graduate electives if their program is planned correctly while still in undergraduate school. Cornell students must still complete fifteen credit hours of work in the Graduate School after the award of the first degree in engineering. The program will not provide a short cut for Cornell students who wish to earn their masters degree. Indeed it is a difficult schedule that requires considerable advance planning. Technical courses can not be substituted for liberal arts subjects.

There are other engineering schools that have programs similar to Cornell's, but none are quite the same. For example, M.I.T. grants an "Engineer degree" following two years of academic study beyond a baccalaureate. It requires advanced study, research and a thesis. Other schools, especially around the metropolitan areas, offer graduate work at night, usually composed of course work.

Participation in the program has increased since its official inception in January, 1956. At present there are about forty candidates studying for their professional masters degree. About 60 percent are from Cornell's undergraduate engineering school. Nine students are working in civil engineering, six in mechanical engineering, sixteen in industrial engineering, four in electrical engineering and five in chemical engineering.

The Graduate Committee plans to expand the program by cooperation with local industries and encouraging their technical personnel to do graduate work. Thus far the program is offered entirely within regular daytime schedules. If interest from engineers in industry should warrant, special scheduling of certain courses either on or off the campus may be possible.

Harry Fertik ME '59

E.E.'s, M.E.'s, A.E.'s, Math, Physics and Chemistry Majors:

Join in the Vanguard of Science

WE have entered the age of fully guided supersonic missile flight. This state can be attributed, in large measure, to scientists and other technical men at the Applied Physics Laboratory (APL) of The Johns Hopkins University. Since 1945 we have been in the vanguard of the guided missile field.

Young engineers and scientists with above-average ability will want to know more about APL: how we built the first ramjet engine, the first large booster rocket, achieved fully guided supersonic flight as far back as 1948, developed TALOS, one of the country's most successful long range missiles, and how we are presently engaged in missile programs of such urgency that little is spared to facilitate their progress.

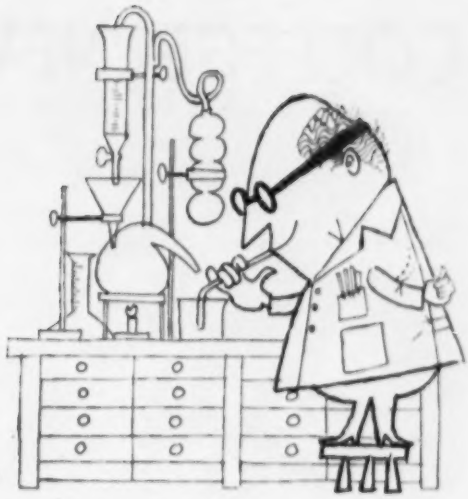
You'll also be interested in finding out why the record of achievement of our 550-man engineering and scientific staff is exceptional, about how we can allow greater scope for creative thinking because our sole goal is technical achievement.

Our laboratories, covering over 350,000 square feet, are located in rolling countryside midway between Washington, D. C. and Baltimore, Md. These facilities, combined with those of our 18 major contractors and Government test stations provide exceptional opportunities for staff members to develop and extend their capabilities.

For detailed information on APL, an organization of and for technical men and scientists, ask your Placement Officer for our new 30-page publication or write: Professional Staff Appointments.

The Johns Hopkins University Applied Physics Laboratory

8621 Georgia Avenue, Silver Spring, Maryland



Look around you...

PPG *makes big things happen in exciting products*

Paints, chemicals, glass, plastics, fiber glass . . . all these products have exciting family trees. And at Pittsburgh Plate Glass Company, tomorrow's offspring promise to be even more intriguing.

Look around you . . . at paint, for example. It's much more than mere color. Paint protects. It must be thoroughly researched and carefully compounded to withstand infinite variations of atmosphere, heat, stress and other conditions. Or look at chemicals . . . their roles in the creation and development of textiles, metals, paper, agriculture, missiles, medicine. You name it; chemicals are there, making important contributions. Glass? These days, it can be made to remain rigid at blast furnace temperatures, withstand supersonic speeds, have the tensile strength of bronze. And it's much the same story for plastics and fiber glass. Everywhere you look—in architecture, industry, the home, *everywhere*—PPG products find new, exciting applications with fascinating and challenging potentialities.

Are you seeking a career that requires creative thinking, utilizes all your skills and know-how, offers a chance to learn the latest techniques? Then look into your enticing career possibilities with the Pittsburgh Plate Glass Company. Contact your Placement Officer *now*, or write to the Manager of College Relations, Pittsburgh Plate Glass Company, One Gateway Center, Pittsburgh 22, Pennsylvania.

75th ANNIVERSARY 1883–1958 PPG

PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS • FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

345 PLANTS, MERCHANDISING BRANCHES, AND SALES OFFICES LOCATED IN 250 CITIES

COLLEGE NEWS

MISSILE MATERIALS TALK GIVEN BY ME PROFESSOR

The problems of keeping aircraft and missiles from disintegrating under high speeds was discussed by Paul P. Bijlaard, Professor of Mechanics at Cornell University's Department of Engineering Mechanics, at the annual meetings of the Institute of the Aeronautical Sciences at the Hotel Sheraton Astor on January 27-30.

Professor Bijlaard's talk was entitled, "Thermal Stresses and Deflections in Rectangular Sandwich Plates." He has been engaged in research for the Bell Aircraft Corporation in Buffalo, New York, for a number of years, investigating the most effective materials to use for plates in supersonic aircraft and high-speed missiles.

"The strength of materials used in modern aircraft is of the utmost importance," Professor Bijlaard says. "We know that sandwich plates, made of two thicknesses of aluminum or steel with a light material such as balsa wood sandwiched between, are better able to withstand the tremendous heat generated when objects travel at high speeds."

Professor Bijlaard has been at Cornell since 1949. He received his engineering degree in Holland in 1920, and for a number of years was a bridge engineer for the state railways system in the Netherlands East Indies. From 1928-1947, he was Professor of Engineering at the University of Bandung, and from 1947-1950 was Professor of Mechanics at the University of Delft in Holland.

For a number of years, Professor Bijlaard acted as government consultant in the Netherlands East Indies, working on the design and construction of harbors, naval bases and bridges.

He was made a Knight in the Order of the Netherlands Lion in 1941.

MALTI RECEIVES AWARD FROM AIEE

A certificate of appreciation has been awarded to Michel G. Malti, Professor of Electrical Engineering at Cornell University, by the American Institute of Electrical Engineers.

Professor Malti received the award in recognition of his services as chairman of the applied mathematics subcommittee from 1953-57, at a meeting of the Ithaca Section.

He has been at Cornell since 1922, receiving the M.E.E. degree in 1925 and the Ph.D. in physics in 1927. Professor Malti has done consulting engineering work for various corporations, and was consultant to the U.S. Navy from 1942-43.

In 1953, Professor Malti was cited by the Syrian and Lebanese American Federation for his contributions to science.

A native of Lebanon, Professor Malti received the A.B. degree from the American University of Beirut in 1915, and the B.S. in Electrical Engineering from the Georgia School of Technology in 1922. He is a Fellow of the Royal Society of Arts.

He has published numerous books and articles on circuit analysis, Laplace-Fourier Transform, and electrical machine design.

Photo Science

Professor Michael G. Malti

UNIVERSITY RAISES TUITION $150 PER YEAR

Cornell University will increase tuition and fees to a total of $1,250, effective July 1, 1958. The $150 increase was voted by the Board of Trustees meeting in New York City, January 25.

The following divisions will be affected: Engineering, Architecture, Arts and Sciences, Business and Public Administration, Law, Medical College, Unclassified Division and the Graduate School.

The new tuition charges and fees will enable Cornell to raise faculty salaries and increase the amount of student aid, scholarship and fellowship funds.

Deane W. Malott, president of Cornell, commented as follows:

"In the field of education there is no more pressing problem than the need for improving the economic status of the faculty.

"Cornell feels that by increasing the scale of faculty salaries we can continue to attract and keep eminent staff members whose direct contributions to our students can never be measured in terms of dollars and cents.

"Few will question the importance of quality education in the world which our students face. We are determined to supply the best education for the future leadership of our nation."

RADIO SCIENCE'S HISTORY AND APPLICATIONS DISCUSSED

"The most important goal of radio astronomy is to extend its range to determine if we are in a universe of creation," stated Dr. Olaf E. H. Rydbeck in his lecture "Radio Science . . . And Beyond" in Olin Hall on January twenty-first. He said that we already have a picture of our own galaxy. "We now are in need of more advanced and powerful equipment to explore the other galaxies of the universe."

Enumerating on the applications of radio astronomy in terrestrial investigations, Dr. Rydbeck ex-

plained how from electromagnetic waves emitted from distant stars in our galaxy we are able to measure the width and thickness of the galaxy and study the constantly moving spirals of stars that are on its outer edges.

Dr. Rydbeck was introduced by John McMamus, Assistant Dean of the College of Engineering, who explained that Dr. Rydbeck is the first Victor Emanuel Visiting Professor of Engineering at Cornell. The professor began his lecture by relating the simple beginnings of radio science by Marconi. "Today in our highly technical world we don't appreciate the achievements of Marconi and his contemporaries," stated Rydbeck. He continued by describing how the infant science was hindered by mathematical theory, which, although accepted at that time, was later proved to be incorrect.

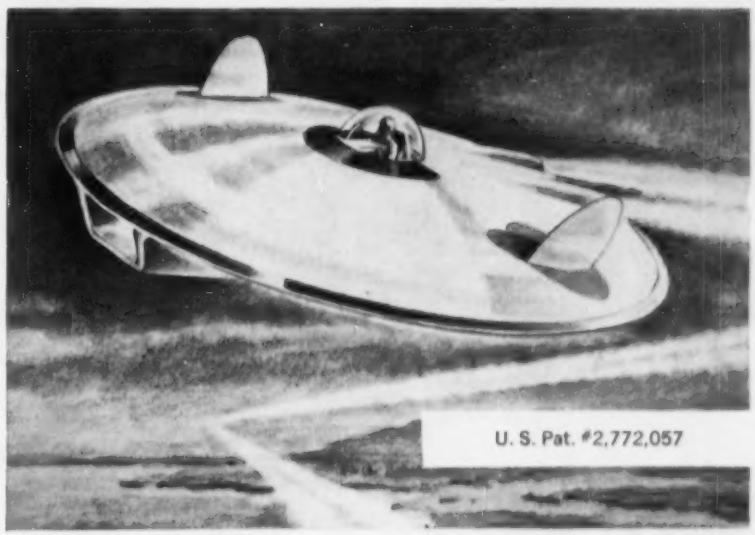
The mathematical theory did not take into account the layer of charged particles surrounding the earth, which we now call the ionosphere. Thus, according to the theory, radio waves should be dissipated at relatively short distances from their point of emission. However, because the ionosphere acts similar to a mirror, radio waves are reflected downward and therefore are able to travel much greater distances. This mirror of charged particles, due to the ionization of oxygen and hydrogen by the sun's rays, was postulated in 1910 but not substantiated with experimental data until years later.

Dr. Rydbeck continued and explained the complex relationship between aurora, storms on the sun and radio wave interference.

The Victor Emanuel Visiting Professorship was established for a two-year period by the Avco Manufacturing Company in honor of Victor Emanuel, Cornell '19, who is a trustee of the University.

A specialist in microwave tubes and radio wave propagation Dr. Rydbeck is at present Professor of Electron Physics and Director of the Research Laboratory of Electronics at Chalmers University of Technology, Sweden. He is a member of numerous honorary societies, including the Royal Academy of Science of Sweden, which awards the Nobel Prizes.

MARS outstanding design **SERIES**



saucer secret?

Whose incredible design is the flying saucer?

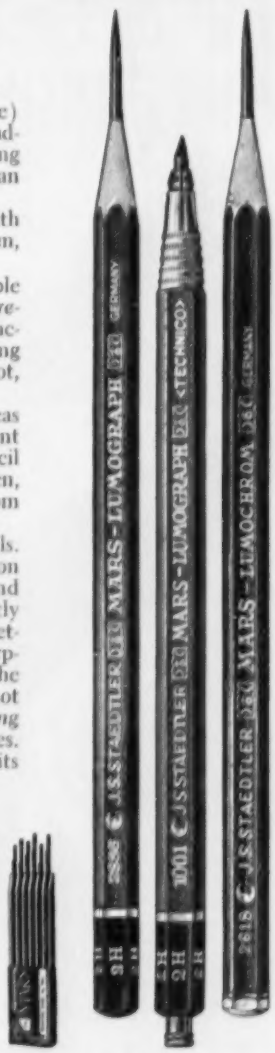
These flying objects (unidentified, of course) maneuver at high speed, with human-crushing suddenness. Their unearthly behavior poses a perplexing problem to imaginative designers: how might man survive in them?

John C. Fischer, Jr. approached the problem with this circular aircraft and its unique control system, U. S. Pat. #2,772,057.

This "saucer's secret" is a rotatably adjustable shell (upper) and a pilot's compartment which *pre-rotates* toward the direction to be flown. The functional design "humanizes" saucers because the rotating provisions distribute *g-forces* laterally on the pilot, minimizing blackouts.

No one can be sure which of today's new ideas will become reality tomorrow. But it will be important then, as it is now, to use the best of tools when pencil and paper translate an idea into a project. And then, as now, there will be no finer tool than Mars – from sketch to working drawing.

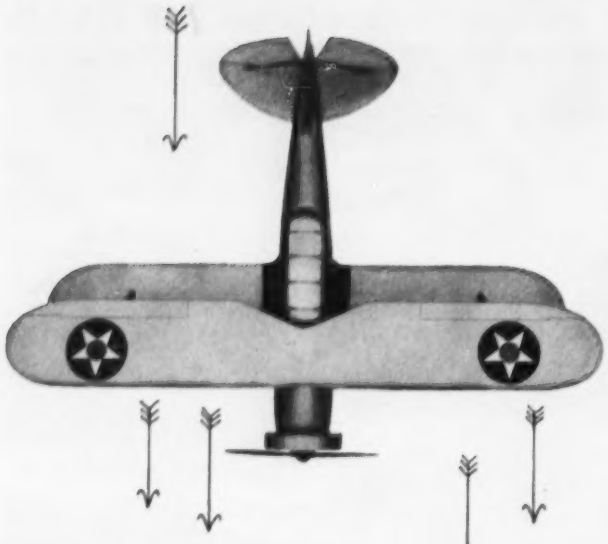
Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and – last but not least – the Mars-Lumochrom, the new colored *drafting* pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.



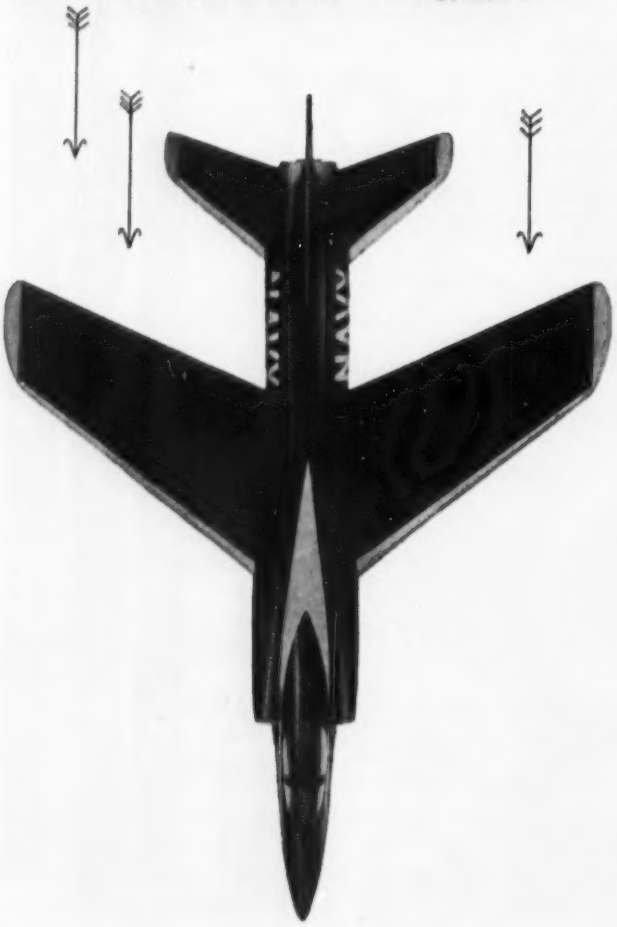
The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored *drafting* pencil, 24 colors.

J.S. STAEDTLER, INC.
HACKENSACK, NEW JERSEY

at all good engineering and drawing material suppliers



FROM FF-1 TO SUPERSONIC TIGER



Sum total: 27 years of Grumman experience! With many firsts along the way. The first military plane with retractable landing gear. The first carrier-based aircraft with folding wings. First swept-wing jets on operational service with carrier squadrons. First in the air with area-rule (coke bottle) fuselage for fighters. The first aircraft capable of performing the complete search-attack mission against subs. First in amphibians with the production of more such craft than the rest of the world combined. First with two-place transonic jet fighter-trainers.

Sum Total: more than 24,000 planes. Ready in quantity when needed. At minimum cost to our government. And backed by unexcelled operational and maintenance field support throughout the world. Small wonder Grumman products have been in uninterrupted service every day of every year since 1930.

GRADUATE ENGINEERS: Write about opportunities at Grumman to Mr. A. T. Wilder, Engineering Personnel Director.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION
BETHPAGE · LONG ISLAND · NEW YORK

Air Superiority Fighters · Anti-submarine Aircraft
Jet Trainers · Air Transports · Nuclear Research

Now on many supertankers, ductile iron is a new material widely used by today's engineers in designing heavy-duty equipment.

Ductile Iron... another Inco Research first

Over five miles of ductile iron pipe going into many of today's supertankers

A deep sea tanker takes many a heavy beating when waves are rough.

With each pitch and roll, she has to *weave*. And her five or more miles of piping have to weave with her.

If it is ductile iron piping, every pipe length *gives* without break or leak.

Bends without breaking

Ductile iron is not only ductile, but also tough. And resistant to the corrosive action of sea water and sulfur laden crude oil.

In some tankers, gray cast iron pipe resists corrosion for ten years or more. Sometimes, though, it's cracked and broken by the pounding of heavy seas that overtax its strength.

In other tankers, steel pipe outrides such storms without damage. But it corrodes so badly it may have to be replaced every three or four years when handling sour crudes.

Ductile iron pipe, tanker owners find, combines the low cost and demonstrated corrosion resistance of cast iron with the tough strength of carbon steel.

So today, many of the newest tankers carry pipe and fittings of ductile iron.

Ductile iron also under city streets

The properties that prove ductile iron pipe suitable for tankers also commend it to municipal and utility engineers. So this shock-and-corrosion resisting pipe is used for water and gas mains. It may soon be under the streets in your town.

Ductile iron has many uses—from plowshares to jet plane parts. And cost-conscious industry is constantly finding new ways to use this versatile money-saving, Inco-developed material.

For free booklet, "Engineering Properties and Applications of Ductile Irons," write: Dept. 232G, Educational Service, Development and Research Div.,

The International Nickel Company, Inc.
New York 5, N. Y.

©1958, T. I. N. Co., Inc.

INCO **International Nickel**

The International Nickel Company, Inc., is the U. S. affiliate of The International Nickel Company of Canada, Limited (Inco-Canada) – producer of Inco Nickel, Copper, Cobalt, Iron Ore, Tellurium, Selenium and Platinum, Palladium and Other Precious Metals

Henri Poincaré...on disinterested fools

"But scientists believe that there is a hierarchy of facts, and that we may make a judicious choice among them. They are right, for otherwise there would be no science, and science does exist. One has only to open one's eyes to see that the triumphs of industry, which have enriched so many practical men, would never have seen the light if only these practical men had existed, and if they had not been preceded by disinterested fools who died poor, who never thought of the useful, and who were not guided by their own caprice.

What these fools did, as Mach has said, was to save their successors the trouble of thinking. If they had worked solely with a view to immediate application, they would have left nothing behind them, and in face of a new requirement, all would have had to be done again."

—*Science et méthode, 1912.*

THE RAND CORPORATION, SANTA MONICA, CALIFORNIA

A nonprofit organization engaged in research on problems related to national security and the public interest

one little...
two little...
three little...

...indians! Anyway you stack the totem pole, there's very little creative work done by this row of engineers. But how do you pick a job that allows a little freedom for initiative . . . where a creative spark can help you advance? As the guy in the middle said . . ."how?"

We'd like to suggest that you investigate a company's reputation for new products . . . for being the leader in its field . . . for a willingness to begin new and untried projects. This approach should locate a company that is aggressive, eager to have its engineers progress and be rewarded. Indeed, a company to have this reputation *must* think of an engineer as more than just one of a crowd.

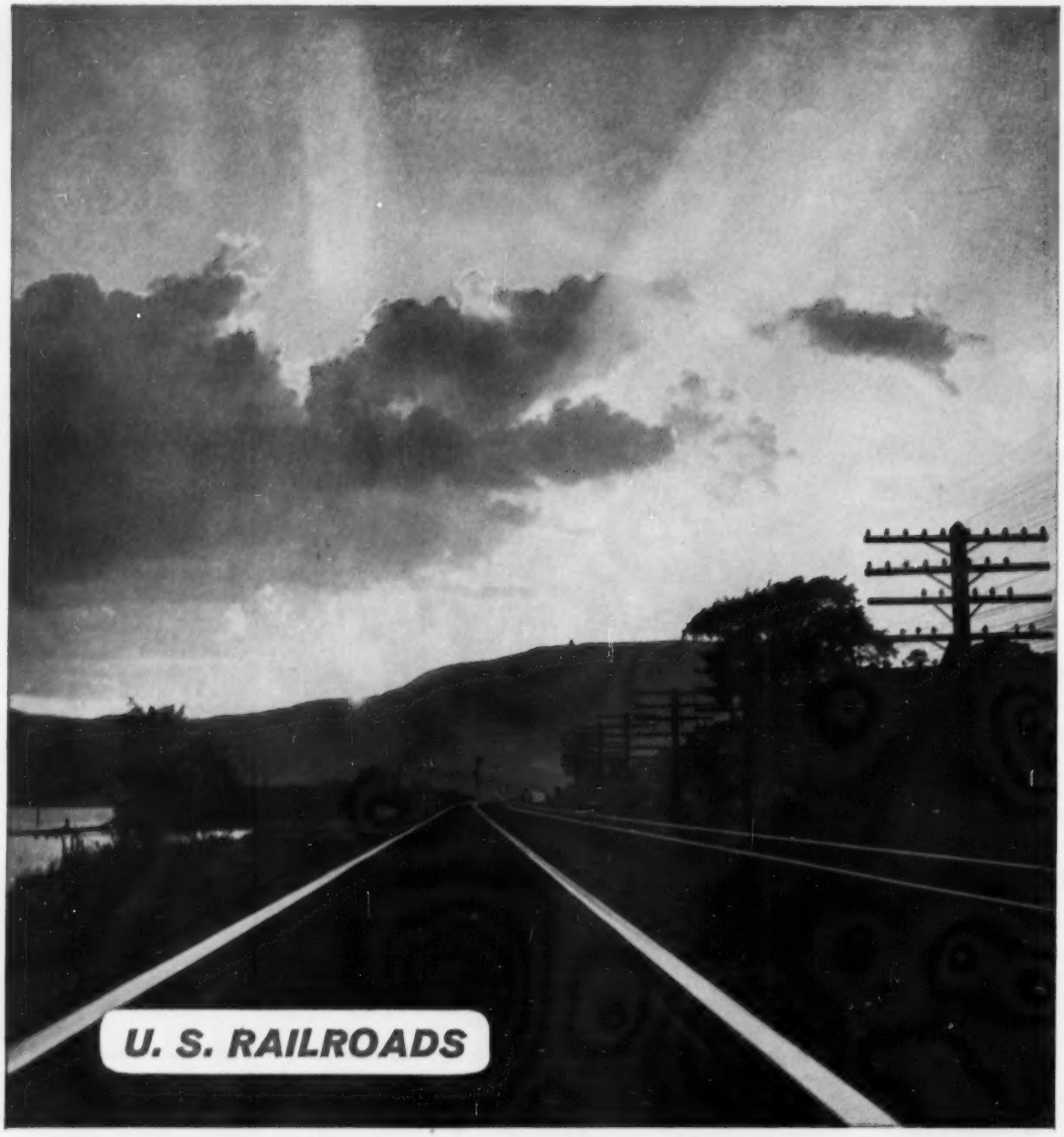
Your professors and placement officer are your best source for information about our reputation. We would, however, like to tell you about the varied products of LINDE . . . from synthetic crystals (developed at LINDE) to our famous HELIARC welding. You'd like to know, for example, that LINDE engineers are not required to do drafting, bench work . . . because they have specialized technicians in these fields. And, there are many other things . . . but our booklet "Look to LINDE for your future" tells this story. Ask your placement officer for a copy or write Dept XX-00. Linde Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

A LEADER FOR 50 YEARS

The terms "Linde," "Heliarc" and "Union Carbide" are registered trade-marks of UCC.

Linde

UNION CARBIDE



Where Engineers Can Move Ahead Faster

America's Railroads offer young engineers a particularly fast track to an interesting and challenging future. The reasons are clear. Our railroads are putting through an enormous program of automation and modernization. They are vital to America's economy and defense. And their need for you is very great. Their present management teams are looking forward to future successors. Retirement rates are currently high; and replacements are brought up from within. If you'd like to consider the unusual opportunities and rewards open to engineers of all types in railroading, see your placement officer or write us at 30 Church Street, New York 7, N. Y. We know you will like working with America's railroads. We've been doing it ourselves for many years—in supplying this great industry with Kerite quality insulated wire and cable.

KERITE CABLE

it's the **KERITE** *that makes the difference*

SCHOOL OF ELECTRICAL ENGINEERING

CLASS OF 1958

Photo Science

1. White, Mark P.; 2. Osofsky, Abraham J.; 3. Blair, William E.; 4. Keene, James H. III; 5. Hollman, Bruce Z.; 6. Brierley, Donald H.; 7. McKinney, Edward J.; 8. Bardash, Irwin; 9. Cohn, Jerome; 10. Benhaim, Ned; 11. Epstein, Ira; 12. Van Horn, J. M.; 13. De Nicola, Michael W.; 14. Menger, Karl S.; 15. Ten Broeck, Craig A.; 16. Sears, Raymond W. Jr.; 17. Collard, Allison; 18. Maassoff, Francis F.; 19. Criswell, Thomas; 20. Woodson, Robert; 21. Phillips, Thomas A.; 22. Levine, Stephen W.; 23. Dana, Arthur W. Jr.; 24. Wolf, Peter H.; 25. Dunbar, Ronald C.; 26. Taft, Russell H.; 27. Beltz, John P.; 28. Curtice, Walter R.; 29. Whalen, James; 30. Grimm, Donald S.; 31. Martin, Robert B.; 32. Gillett, Kenneth; 33. La Tour, John Jr.; 34. Todd, James L. Jr.; 35. Poll, Jerry G.; 36. Williams, Robert A.; 37. Reitenbach, Nicholas; 38. Lutz, William E.; 39. Surtes, Martin; 40. Vulcan, A. I.; 41. Romaine, John E.; 42. Yohannes, Tamene W.; 43. Rude, Robert H.; 44. Kleckner, Keith R.; 45. Krall, William C.; 46. Sullivan, Francis P.; 47. Hirsch, J. Arthur Jr.; 48. Rosenbaum, Paul; 49. Feinberg, Eugene J.; 50. Perles, Anthony H.; 51. Douglass, Joseph D. Jr.; 52. Sacks, Gerald E.

SCHOOL OF CHEMICAL AND METALLURGICAL ENGINEERING

CLASS OF 1958

Photo Science

1. Tevebaugh, C. Richard; 2. Ryan, Dwight F.; 3. Dent, Richard D.; 4. Barnum, Robert J.; 5. Stansfield, James E.; 6. Horton, Bernard S.; 7. Tuffnell, Glenn W.; 8. Olt, Theodore F. Jr.; 9. Steele, Robert H.; 10. Kammerer, Henry G.; 11. Forgeng, William D. Jr.; 12. Seidel, Robert L.; 13. Simpson, Oscar S. Jr.; 14. Goldman, Samuel D.; 15. Hutchison, Harold S. Jr.; 16. Sacerdote, Albert; 17. Oswald, Richard W.; 18. Hanna, Robert C. Jr.; 19. Chamberlin, L. E.; 20. Wood, Ross; 21. Hardman, James V.; 22. Wills, Walter; 23. Horton, Philip G.; 24. Bradley, George R.; 25. Zachmann, George J.; 26. Wascheck, Charles J.; 27. Schmidt, William; 28. Deighton, Brinton S. Jr.; 29. Long, Michael J.; 30. Sagal, Matthew W.; 31. Beyer, Myron S.; 32. Hanle, William R.; 33. Coburn, Mathias M.; 34. Hunter, Daniel R.; 35. Markley, Jay L.; 36. Steward, F. Gordon; 37. Walker, William L.; 38. Tarbell, James V.; 39. Novak, Darwin A. Jr.; 40. Leonard, Donald A.; 41. Graves, Richard; 42. Warrington, Robert T.; 43. Schumacher, William T.; 44. Lorig, Bruce C.; 45. Schaefer, Andrew R.; 46. Butler, William R.; 47. Henry, Guido; 48. Rosborough, James W.; 49. Steinberg, Donald H.

Theodore J. Kauffeld, M. E., P. E.

Consulting Engineer

•

PLANS - SPECIFICATIONS, FIELD SUPERVISION - REPORTS

INDUSTRIAL AND CHEMICAL PLANTS

HIGHWAYS - PIPE LINES - TRANSMISSION LINES

AIRPORTS - SCHOOLS - HOSPITALS - HOUSING PROJECTS

WATER SUPPLY - SEWERAGE - LABORATORIES

STEAM AND ELECTRIC POWER PLANTS

SUB-STATIONS - SWITCHING STATIONS

HEATING - VENTILATING - AIR CONDITIONING

•

150 BROADWAY

NEW YORK (38), N. Y.

DIgby 9-4488

14K OPPORTUNITY

for

NEW ENGINEERS

of

PIONEERING STOCK

DO YOU have an affinity for the infinite? An urge to reach beyond our present limits of knowledge... and our current frontiers of development? There is a tremendously intriguing program underway at Hamilton Standard in the fields of missile, rocket, atomic engine... and advanced aircraft equipment development. You owe yourself the complete details.

WRITE TO MR. T. K. BYE

HAMILTON STANDARD

DIVISION OF UNITED AIRCRAFT CORPORATION

00 Bradley Field Rd., Windsor Locks, Conn.

TECHNIBRIEFS

NEW ENERGY TRANSFER DEVICE INTRODUCED IN GYROMATIC WATCH

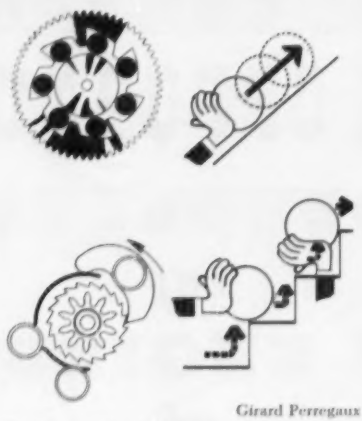
A patented new mechanism, called the Gyrotron, which has been termed one of the most unique converters of movement in existence today, has been unveiled by Girard Perregaux and Co. as the heart of a watch self-winding mechanism.

The device, which now permits a transmission of power to the mainspring with no mechanical resistance will perform better, wear longer and require less service than its counterpart in other movements. The Gyrotron was noted in its recent introduction in Europe as, "A technical invention of ingenious simplicity."

Although no additional uses have yet been considered, the company says that its invention is applicable where a gear is used to transfer energy, since it converts a gear into a continuous free-wheeling clutch. The company also states that the use of two Gyrotrons provides an automatic clutch and rotation inverser system.

The Gyrotron has solved the problem of converting the motion of a swinging weight, or "rotor" into a unidirectional and continuous rotation without the mechanical resistances of clicks, springs and ratchets. This has been achieved by replacing the latter components, which are subject to wear, with a free wheel clutch mechanism employing jeweled bearings, or "rollers," which are harder than steel and require no oiling.

Dr. Lloyd Motz, Professor of Physics and Astronomy, Columbia University, describes this development in his latest publication, "The History Of Time." He says, "We can understand why the Girard Perregaux device is superior to all others by comparing what happens when a man carries a weight up a flight of stairs, with what happens when he pushes the weight up an inclined plane of the same height. In the first case, he must do at least enough to carry the weight to the next higher step. If he does less than this, the weight will fall back



Girard Perregaux

Gyrotron wheel (upper left) transfers energy continuously and without mechanical resistance. Operation is comparable to pushing a weight up a plane, where each bit of energy will move it up at least slightly. Contrast is with a conventional gear using click and spring which exerts a resistance similar to that of moving a weight up some stairs.

. . . The mechanism is similar to pushing the weight up the inclined plane; however small an amount of energy is expended by the man, the weight will move a slight amount up the incline and finally come to the top."

The notch is not of uniform radial depth, with the dimension increasing progressively from one end to the other. When the roller is in the narrowest part of the notch, it is forced under pressure into contact with the disc, which is therefore coupled to the ring gear. This takes place when the latter is driven in a particular direction by a swinging weight. If the weight is going in the opposite direction, the ring is also turned in reverse, and each roller is forced to move to the widest part of the notch, so that the disc now becomes free.

X-RAYS AMONG LATEST POLICE IDENTIFICATION TECHNIQUES

Cigarettes found at the scene of a crime can be identified and can lead to a criminal, not only by Sherlock Holmes' time-tested brand-identification method, but by determining paper characteristics through "soft" x-ray analysis.

This was one of the techniques revealed to law enforcement officers studying latest photographic methods of crime detection at a seminar held last week at Eastman Kodak Company.

Harris B. Tuttle, Kodak's law enforcement photography consultant, said the seminar covered crime analysis information gathered in preceeding months in such rapidly developing fields as photomicrography, radiological identification, and infra-red photography.

From exhibits at the seminar, it is clear that magazine detective heroes are frequently outdone by their real-life counterpart using modern scientific methods. Photographic methods are keystones of this work, Tuttle said.

X-ray photography can determine the path taken by an embedded slug, when extraction might affect the evidence. The lead from any calibre shell shows up excellently in an x-ray.

X-rays can also provide police with a double-edged tool against dope peddlers. With the x-ray technique, the amount of marijuana in a confiscated cigarette can be determined without destroying the evidence through chemical analysis. Police then have conclusive proof of the original content of the cigarette plus the final evidence from chemical analysis.

Photomicrography has also become important in law enforcement in recent years. Even single human hairs or clothing fibres can be positively identified. By the refinement of color photomicrography, the range of usefulness of this tool in comparing evidence is increased.

Microscopic pieces of paint can be fitted together like pieces in a jig-saw puzzle, and the match photographed to provide conclusive evidence in a hit-run case.

If such matching is not possible, a spectroscopic analysis can be made of paint found at the scene of the crime and compared with the spectroscopic curves of paint taken from a suspected vehicle.

One of the latest developments is the Ektron detector burglar alarm. This device will set off a remote alarm when someone passes through its invisible beam of infra-red radiation.

An alarm of this type can snap an intruder's picture using a flashbulb masked so that only invisible infra-red radiation reaches the subject and exposes the film. Many a thief has unknowingly posed for his portrait in front of such a device, Tuttle pointed out.

Photography can be used to advantage in detecting counterfeit bills. Radiographs provide the greatest assistance. A genuine bill will give a clear portrait, when photographed with low voltage x-rays. A counterfeit bill will usually appear without detail.

Cooperation between police departments and hospitals was also stressed during the seminar. Police can thus apply the latest x-ray techniques practiced in the hospital, both for law enforcement and in an emergency, for human identification.

When disaster occurs, x-ray identification of victims becomes very important, both for humanitarian reasons and for legal procedure. When all other means prove impossible, superposition of x-rays of the skull with earlier photographs can often provide positive identification.

In other cases, the individuality of the bony structure of the fingers, as determined by x-rays, proves invaluable for identification.

NEWLY-DEVELOPED COOLING TOWER TO CONSERVE WATER

A portable water-cooling tower has been developed by the Badger Manufacturing Company of Cambridge, Mass., and the Engineer Research and Development Laboratories, Fort Belvoir, Va., for use with the Army's mobile liquid carbon dioxide generating plants in the field.

The unit, which permits re-use of about 90 per cent of the water consumed by the plant each minute, is now undergoing tests with 300-pound-per-hour plants at Fort Belvoir.

In high ambient temperatures, plants of this capacity require as much as 200 gallons water a minute for cooling purposes. Approximately 15 gallons of water used in the plant's contact scrubber forms a weak sulfuric acid and must be thrown away. Five to 10 gallons of water are also lost each minute due to evaporation.

The unit consists of a tower section and an operating platform mounted on a semi-trailer. The tower is divided into four compartments. Each contains a packed section filled with 40 cubic feet of polyethylene tellerette, a wire mesh mist eliminator, and a 7.5 horsepower axial flow fan. A 240-gallon per minute recirculating water pump, pressure gauges, thermometers, electrical control panel, water filters and a water treatment tank are mounted on the operating platform in front of the semi-trailer.

The tower, a countercurrent induced draft type, has a capacity of 3,000,000,000 BTU per hour. In operation, hot water from the plant is sprayed from nozzles on the top of each packed section. It then falls through the packing and drops into a common sump, where it is picked up by the pump and re-circulated. Fans, mounted on the top of each compartment, pull air through louvres located in the bottom of the tower upward through the packing, where contact with the downward flowing water accomplishes cooling by a combination of evaporation and sensible heat transfer. The air passes through the mist eliminator, where entrained moisture is removed and is then discharged through the fan.

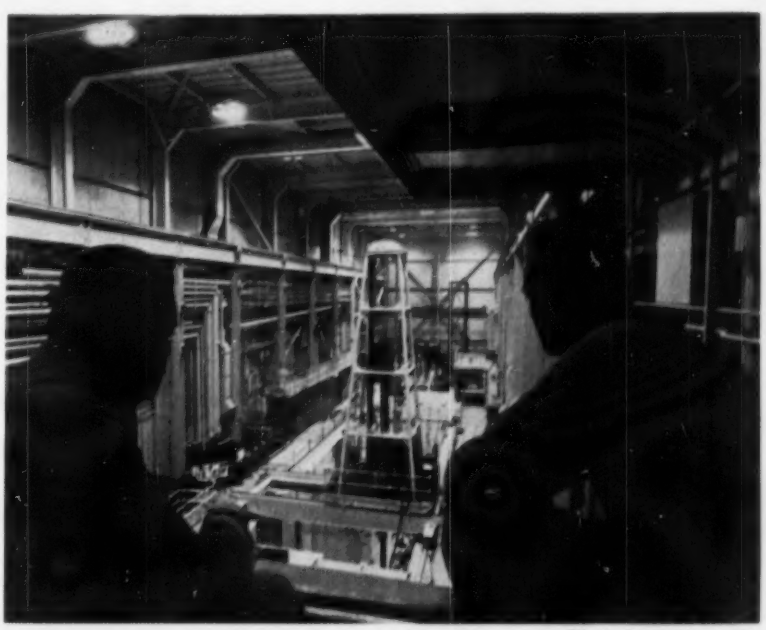
FIRST ATOMIC POWER PLANT FOR CIVILIAN OPERATION

On December 2, 1957, residents of Pittsburgh began receiving electricity produced by atomic power.

The plant, located in Shippingport, Pennsylvania, is the first full-scale central station atomic power plant developed exclusively to civilian purposes.

The nuclear portions of the plant were designed and constructed by Westinghouse Electric Corporation in conjunction with the Duquesne Light Company of Pittsburgh, which will operate the entire plant for the Atomic Energy Commission.

The heart of the entire system is the core, within which the "hot" nuclear reaction or fission process takes place. The nuclear furnace heats high pressure water which passes through a heat exchanger, turning a second supply of water into steam. The fifty-eight-ton core is only six feet long, and somewhat more than six feet in diameter. It includes fourteen tons of natural



Westinghouse Electric Co.

First atomic power plant for civilian use: Inside the fuel handling canal building is a derrick-like structure which supports a special fuel element extraction tool. When the uranium fuel elements are replaced in the nuclear reactor, they will be handled remotely by this "mechanical hand" and will be kept under water in the area beneath the derrick.

uranium surrounding some 165 pounds of highly enriched uranium "seed." There are thirty-two "seed" fuel elements and 113 natural uranium elements in the core.

The core is housed in a stainless steel container, or pressure vessel. The interior of the vessel, which stands thirty-three feet high and has an inside diameter of nine feet, is lined with one-quarter-inch-thick stainless steel that provides maximum corrosion resistance.

The operating weight of the reactor, including the uranium fuel, is more than 250 tons. It is the heaviest piece of atomic equipment in the world.

Within the nuclear reactor are thirty-two control rods for controlling the atom-splitting or heat-producing process. Inserting the rods into the reactor slows the fission process; withdrawing them speeds it up. The rods are made of hafnium metal which was selected because by readily absorbing neutrons it affords careful regulation of the fission process.

Extremely pure water, which serves both as moderator and coolant, flows at the rate of 18,000 gallons per minute through each of four main coolant loops in the plant to produce the 60,000-kilowatt minimum power. The water is at 2000 pounds per square inch pressure with an average temperature of about 525 degrees Fahrenheit.

The entire nuclear portion of the power plant is housed in four steel containers which, in turn, are in concrete compartments partially below the ground level. The exterior of the facility does not look too different from a conventional power plant except for the absence of large stacks and fuel storage and handling facilities. Over-all control of the plant is from a single control center.

ALUMINUM "QUICK-QUENCHED" IN AN AUTOMATIC ELEVATOR

A problem in fast quenching heat-treated aluminum at the Boeing Airplane Co., Seattle, Wash., has been solved by the installation of an electric elevator furnace, equipped with an automatic elevator quench, which transfers the load from furnace to quench in just seven seconds.

The furnace, shown in operation at the Boeing plant, was designed and built by General Electric. It has four zones, handles a 4,000 lb. charge at 1,000 degrees F maximum operating temperatures. Temperature variation throughout the load is 10 degrees F or less after stabilization at control temperature.

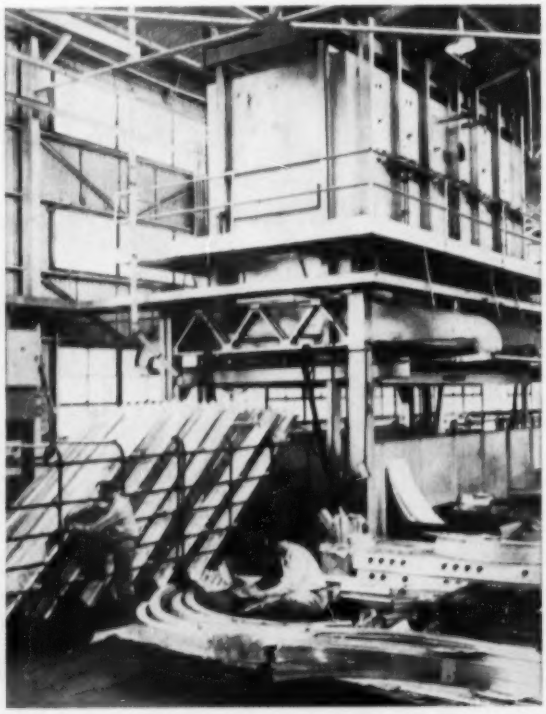
Loads of coiled 24 S aluminum alloy sheet materials as large as 6 ft. wide and 12 ft. long are regularly processed in the furnace. Remote recording thermocouples are used during performances testing. Within 15 minutes, most of the load is at temperature, and 20 minutes the inner-most part of the coils reaches the heat-treat temperature. Similar rapid heating is obtained on extrusion and formed parts loads.

NBS DEVELOPS PORTABLE CLAMP-TYPE AC MICROAMMETER

A portable, battery-powered, new transistorized microammeter developed at the National Bureau of Standards provides a rapid, convenient method for measuring small alternating currents. Since the current pickup is a miniature split-core transformer that can be clamped onto a wire, it is unnecessary to open the circuit to make the measurement. Lowest range of the prototype instrument is 200 μ a full scale, and on higher ranges it can accurately determine currents as large as 200 ma. Its frequency range is 50 cps to 100 kc. Instruments embodying the same principles can be used for materially lower and for very much higher ranges. The development was carried out as a part of some work in basic instrumentation, a cooperative program sponsored by the Department of Defense, the Atomic Energy Commission, and NBS, and was conducted by G. F. Montgomery and C. Stansbury of the Bureau's electronic instrumentation laboratory.

For many years, it has been common practice to extend the range of current-indicating instruments by using current transformers. For convenience, the transformer often consists of a secondary winding on a split core that can be clamped around the conductor carrying the

(Continued on Page 70)



General Electric

Heat treated aluminum is transferred from furnace to quench in just seven seconds by this elevator furnace equipped with an automatic elevator quench.

Engineers, Scientists, Mathematicians...

Two important reasons for starting your career with Lockheed Missile Systems

■ **Better Advancement Opportunities**

■ **Higher Degree Educational Program**

As greater emphasis is put on missile's role in U.S. defense, our own missile projects will continue to expand. This growth potential – coupled with our youth as a division – means better opportunities for you to move rapidly ahead in a career with Lockheed Missile Systems.

Under the Advanced Study Program, the Lockheed Graduate Study Council offers qualified students the opportunity to earn advanced degrees while employed in their chosen fields at Lockheed Missile Systems.

Eligible students must be U.S. citizens holding B.S. or M.S. degrees in engineering, mathematics, or science applicable to missile systems research and development.

Extensive laboratory facilities at Palo Alto and Sunnyvale, near Stanford University, provide an atmosphere to satisfy the most inquisitive scientific mind, yet pique the desire for further knowledge and achievement. Both locations are less than an hour's drive from San Francisco.

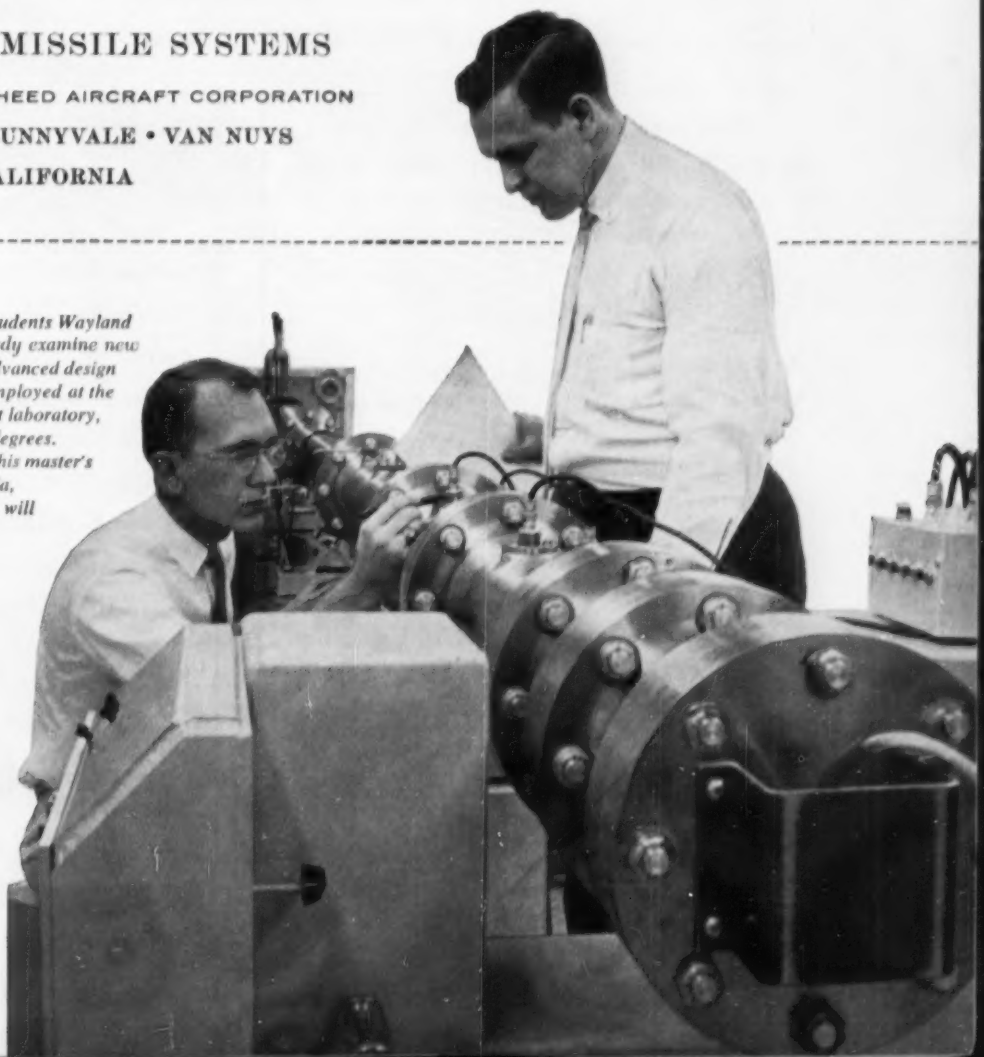
For further information, contact your Placement Officer, or write College Relations Office, Lockheed Missile Systems, 3251 Hanover Street, Palo Alto, California.

Lockheed MISSILE SYSTEMS

A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE • VAN NUYS

CALIFORNIA



Advanced Study Program physics students Wayland Marlow III, right, and Jerry Kennedy examine new 44-foot shock tube being used for advanced design work on Polaris missile. Both are employed at the Lockheed research and development laboratory, Palo Alto, while earning advanced degrees. Kennedy, Oklahoma '56, is earning his master's degree at the University of California, Berkeley, while Marlow, Miami '55, will attend Stanford University for his doctorate.

CRESCENT TYPE SH-D 5000 VOLT TRAILING CABLE

For supplying power to electric shovels, dredges, etc.
Shielded to assure protection to personnel and equipment.

CRESCENT Wires and Cables are produced with modern equipment to the most exacting specifications. Every foot is subjected to searching electrical tests during manufacture and in the finished form.

OVER 70 YEARS EXPERIENCE

CRESCENT INSULATED WIRE & CABLE CO.

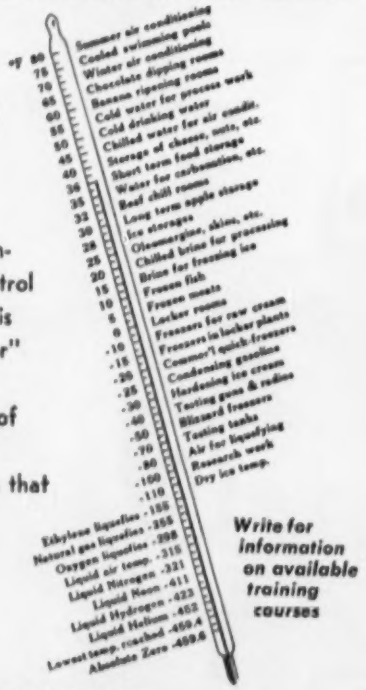
TRENTON 5, N. J.

C. Edward Murray, Jr. '14

Plan your future in the fast expanding
REFRIGERATION and AIR CONDITIONING FIELD . .

FRICK

Engineers solve a wide range of temperature control problems. This "thermometer" suggests the great range of refrigeration temperatures that they meet.



Write for information on available training courses

FRICK COMPANY, Waynesboro, Penna.

AUTHENTIC RECORDINGS OF NATURE'S AMAZING VOICES ARE AVAILABLE IN OUR BOOK DEPARTMENT

Songbirds of America	$4.95
The Mockingbird Sings	2.50
Music and Bird Songs	5.00
Voices of the Night	6.75
Jungle Sounds	5.00
Western Bird Songs	2.50
Florida Bird Songs	2.50
American Bird Songs, Vol. I	7.75
American Bird Songs, Vol. II	7.75

Postpaid

On Hi-Fi, 78 rpm and 33 ⅓ rpm

The Cornell Campus Store

Barnes Hall

trying to catch the brass ring?

better forget it!

No engineering position
worth getting
can possibly offer you
a "free ride".

The old rules still apply:
a successful career
depends on the amount of
ability you have
and on the capacity of a company
to make good use of that ability.

Sikorsky helicopters
have amply demonstrated
our capacity
for putting engineering talent
to constructive use.

They are the most versatile,
most widely used rotary-wing aircraft
in the world today.

For factual and detailed information about careers with the world's pioneer helicopter manufacturer, write Mr. Richard L. Auten, Bridgeport Personnel Department.

SIKORSKY AIRCRAFT

One of the Divisions of United Aircraft Corporation

BRIDGEPORT and STRATFORD, CONNECTICUT

GUERLAC

(Continued from Page 28)

is one with which Harvard has experimented during the past decade. General courses have been instituted that inject a large ingredient of history of science, on the sound if insufficient premise that budding humanists are accustomed to learning about things by discovering how they have developed, and by seeing them in the time dimension and in relation to other aspects of human culture. And since young humanists are interested in people, and the great scientists of the past are people who have accomplished remarkable things, their interest can be readily captured by some use of the biographical and anecdotal approach. Such a course is focussed on the problem of explaining the scientist's logical and experimental methods, the temper of his thought as he confronts difficult problems, and the goals and aspirations of the scientific enterprise. At Harvard, the pioneering institution, this involves the close study of illustrative case histories of scientific accomplishment, drawn for the most part from the earlier (and therefore simpler) science of the past. There is much in favor of this approach; but a strong objection is that it requires a special staff, special facilities, and is therefore extremely expensive.

My own suggestion is simpler, and is based on the venerable proposition that the best way to learn something about science *in general*, is probably to study one science *in particular* and with some thoroughness. But the courses should be profoundly modified to fulfill the desired purpose. The primary aim should be to illustrate, through the materials of the particular science, the process of scientific inquiry, the types of thinking used, the attitude of the scientist towards his materials, and the basic concepts which transform a collection of observed facts into something worthy of being called a science. Everything introduced into the course should be directed to this end, and to this end only. The facts should be selected because they help to illustrate a principle of scientific thought or method. I think the case study method could be introduced with profit, and I am sure that a judicious use of the biographical and historical approach, and some discussion of the relation of the particular science to other sciences and to mankind's other preoccupations will construct a bridge over which the "non-scientist" can pass from the world he knows to the world of science. But the real appeal should be to the student's interest in ideas. If indifferent to things-for-themselves, he can yet be made keenly interested in ideas-about-things. What I am suggesting is that some of the really tough philosophical problems, which the elementary science teacher commonly sweeps under the rug (perhaps because he has never faced them himself), to be introduced and kept constantly to the fore, and that the emphasis be placed on his science as something dynamic and growing, rather than on something fixed and made of so-called "facts" to be memorized and stored away.

In conclusion, I admit it will be easier to imagine than to execute such a program. If only because I can think of very few scientists sufficiently interested, and sufficiently competent, to undertake it. Yet on every campus there are scientists who have thought long and hard about the central problems, who have read some history and philosophy of science, who are themselves creative research men and not mere pedagogues. There are just not enough of them to go around. It is my firm belief that in the long run we must train men specially for the task I have outlined. This is the job of the graduate schools. Yet it will not be accomplished until we change present practice. Though we expect a proportion of our better graduate students to make a career of college science teaching, we give them the same concentrated vocational program we give those who are destined to do development work in industrial laboratories, to become research workers for the Department of Agriculture, or who are counted on to do masterly research on the frontiers of science. Yet a goodly number will do none of these things and will, and should, end up as college teachers; and some of these again—by no means the least competent—will be assigned the task of teaching the introductory courses. If they are to do the job adequately, if they are to communicate to the sometimes very sophisticated "non-scientist," they must be able to do, and do well, some of the things I have sketched above.

EDITORIAL

(Continued from Page 10)

a student has no aptitude for science is not an excuse for his ignorance about the greatest achievements of his age, or the foundations of his future. Science has profoundly influenced philosophy, political history, and economics. The lives of great scientists, mathematicians, and engineers have been examples of the highest possibilities of the human spirit. Yet many liberal arts students know nothing about the basis of the physical freedom from physical labor that enables them to pursue their liberal studies. Teachers in the College of Arts and Sciences should strive to convey the meaning and significance of technical ideas, and to cultivate in themselves and their students an appreciation for the benefits and possibilities of technology. Education for being a human being must include knowledge of man's successful and continuing struggle to liberate himself from slavery by harnessing nature in the service of human need. Failure to do so results in narrowness contradicting the concept of the liberal mind.

Dr. Wernher von Braun, leader in the development of America's successful Explorer satellite, stated last summer, "Technology and ethics are sisters. While technology controls the forces of nature around us, ethics controls the forces of nature within us." For this reason, technical and liberal studies must be closely related in order that educated men can give leadership in solving problems that have not yet been dreamed of, and problems that have perplexed man from the beginning of history. Neither discipline is in itself sufficient for tomorrow. May Cornell educators and students have the vision and dedication to accept this challenge for greater unity of the College of Arts and Sciences and the College of Engineering. R.G.B.

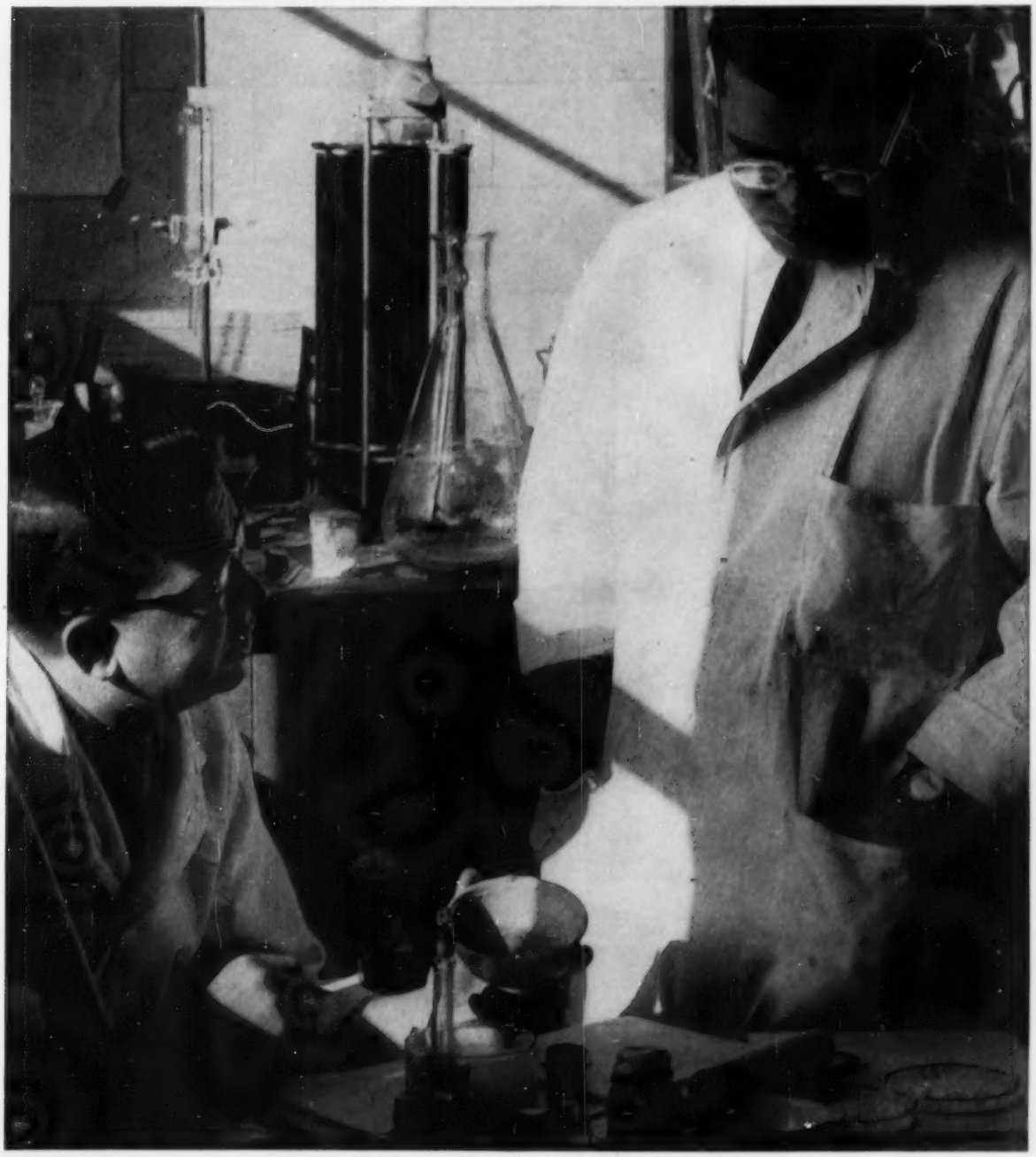
Allied Chemical

What careers are available at Allied Chemical?

Where would *you* fit into the Allied picture? Perhaps at one of our 12 research laboratories, more than 100 plants, or many sales offices throughout the country. What products would you work on? There are more than 3,000 in all—chemicals, plastics, fibers . . . and new ones coming along every year.

At Allied, there are careers for chemists, chemistry majors, engineers (chemical, mechanical, electrical). Facts about these careers are in a new book, "Allied Chemical and Your Future." Why not write for a copy? The Allied interviewer can also answer your questions. Your placement office can tell you when he will next visit your campus.

Allied Chemical, Dept. C-1, 61 Broadway, New York 6, N.Y.



Engineering leadership—a bench mark at Alcoa

In exciting new architectural developments . . . in the automotive industry's drive for the all-aluminum engine . . . in super conductors to meet the nation's insatiable power demands, you'll find Aluminum Company of America in the forefront of technological advances. Alcoa produces and sells nearly one-half of the nation's aluminum . . . conducts about three-quarters of all basic research on aluminum applications . . . maintains the world's largest and most completely equipped light metals research center at New Kensington, Pennsylvania.

To maintain this type of leadership, we need outstanding men, men with top backgrounds in both academics and extra-curricular activities. Men who are trained in the nation's top schools . . . who understand and glory in the challenge of engineering . . . who know that therein lies the basis of a better tomorrow. Today, aluminum serves virtually every area of our industrial, commercial and day-to-day lives. Yet its uses have only just begun to be exploited. Your challenge as an engineer lies in finding new applications, in bringing aluminum to its full potential as a servant of mankind.

Whatever your specialty—metallurgical, mechanical, electrical, industrial, or any other type of engineering—whatever your interest—engineering, production, research, development or sales—there's a clear-cut future for you at Alcoa. Write us today—just fill out the coupon—for your copy of *A Career For You With Alcoa*. Or contact your campus placement director.

ALCOA ALUMINUM

Your Guide to the Best in Aluminum Value

"ALCOA THEATRE"
Exciting Adventure, Alternate Monday Evenings

Please send a copy of A Career For You With Alcoa.

Aluminum Company of America
1825 Alcoa Building
Pittsburgh 19, Pennsylvania

NAME_____

STREET ADDRESS_____

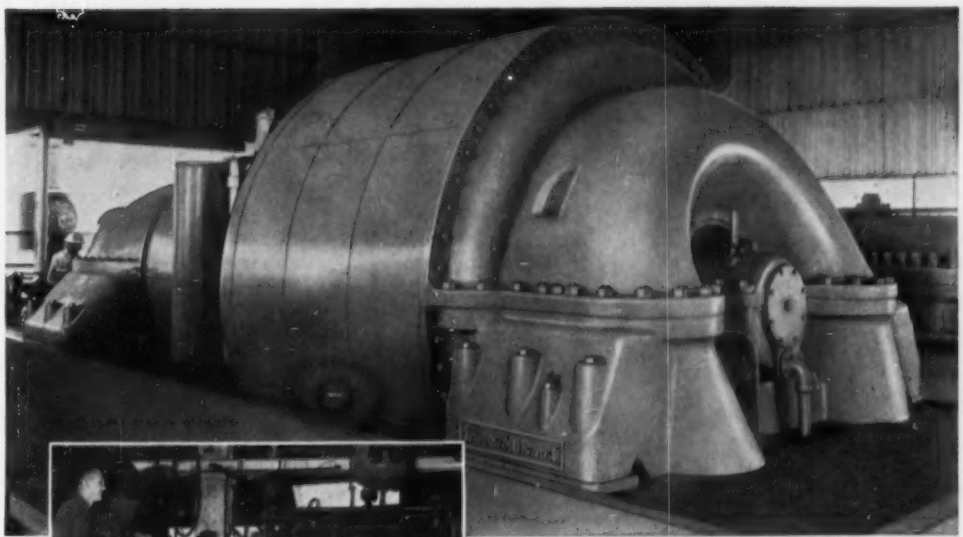
CITY AND STATE_____

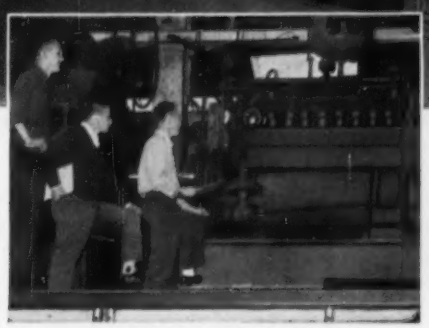
COLLEGE_____ DEGREE_____

DATE OF GRADUATION_____

YOUR ENGINEERING CAREER

with INGERSOLL-RAND

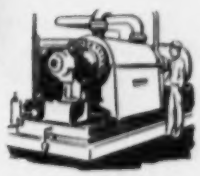




ABOVE: This huge I-R Turbo-Blower is the largest cat-cracking air blower ever built. It delivers 161, 500 cfm of 30 psi air at Tidewater Oil Company's new Delaware refinery, and is driven by an 11,250 hp I-R steam turbine.

LEFT: Engineering trainees at Ingersoll-Rand's Phillipsburg, N. J., plant check final performance tests on another blower of smaller size and higher pressure.

also means LEADERSHIP in

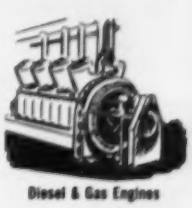


Centrifugal Pumps

Rock Drills

Air & Electric Tools

Steam Condensers



Diesel & Gas Engines

Here's What Blower Engineering at Ingersoll-Rand can mean to you...

WHEREVER industry needs large volumes of compressed air or gases – for steel mill blast furnaces, refinery catalytic cracking units and other petroleum and chemical processes–you'll find Ingersoll-Rand centrifugal blowers on the job. These huge units, delivering thousands of cubic feet per minute, 24 hours a day, are the very heart of our vital process industries.

This means that blower engineering offers you challenging opportunities in a field of major importance. There is a need for every type of creative engineering ability in the design, development and application of such specialized industrial machinery.

Ingersoll-Rand also manufactures the industrial equipment shown at the right. All require a high order of engineering in their design, manufacture and sale.

If you are looking for a leadership career with excellent opportunities for advancement, you'll find it at Ingersoll-Rand. For further details, contact your Placement Office, or write to Ingersoll-Rand, 11 Broadway, New York 4.

OPPORTUNITIES FOR ENGINEERS

- Sales Engineering
- Design Engineering
- Production Engineering
- Business Engineering

Ingersoll-Rand

12-745 11 Broadway, New York 4, N. Y.

ALUMNI ENGINEERS

(Continued from Page 41)

Grant C. Woodard, BSinAE '48, has been promoted to general sales manager of The Cooper-Bessemer Corp., Mt. Vernon, Ohio. He is responsible for the sale of all company products, including centrifugal and reciprocating compressors, diesel, gas and gas-diesel engines to domestic markets. He has been with the company since 1948 and became assistant general sales manager in 1955. Woodard's address is 1115 East Vine Street, Mt. Vernon, Ohio.

CORRECTION:

The first sentence of Dr. Glenn A. Olds' article, "The Challenge of The Soviet Union: Education's Race with Disaster," on page 30 of the February issue should have read as follows:

"Someone has wisely remarked that there are no experts on the Soviet Union, only men with relative degrees of ignorance. . . ."

WINDING

(Continued from Page 30)

be provided for a two-year sequence of electives involving enough total hours to provide the opportunity of sampling more than one non-technical field. Whether or not these electives should be restricted or entirely "free" should depend on the effectiveness of counseling and advising students at this level, as well as specific student interests. Certainly the particular needs of students planning a career in technical sales would be quite different from those considering graduate work to the doctoral level. The student's proficiency in various non-technical areas should also be considered. Perhaps the ideal arrangement would be to leave the electives entirely free and endeavor to improve counseling. This would, of course, require that class advisors use their veto power more freely than they do when elective areas are specified. However, one of Cornell's traditionally favorable policies has been to consider the student as an individual rather than a statistic and to try to fill his specific needs. It would seem that this could best be done with free electives, properly chosen, rather than specifying certain non-technical areas from which electives must be selected.

TECHNIBRIEFS

(Continued from Page 62)

current to be measured. This technique suggested a similar device for measuring small currents at audio and radio frequencies: an instrument consisting of a small clamp-type magnetic probe and a suitable means for amplifying the probe output to operate an indicating meter. Such an instrument would be complementary to the vacuum-tube voltmeter found in all experimental electronic laboratories. The Bureau's device is not only based on the probe-amplifier-meter concept but is transistorized as well for long life and modest power requirements.

LAVA

Manufacturers of Super-Refractories Only

REFRACTORY CRUCIBLES
GRAPHITE CRUCIBLES
HIGH-TEMPERATURE CEMENTS
SPECIAL REFRACTORY BRICK, TILE, SHAPES

From the Following Materials:—

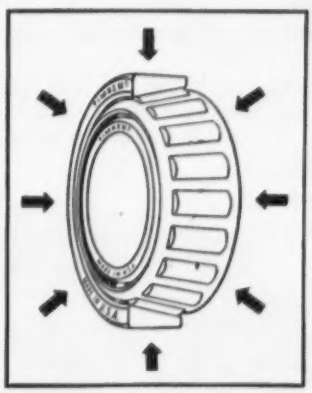
GRAPHITE — SILICON CARBIDE — FUSED ALUMINA — MULLITE
MAGNESIA ZIRCON

LAVA CRUCIBLE-REFRACTORIES CO.
PITTSBURGH, PA.

Tear out this page for **YOUR BEARING NOTEBOOK...**

How to make a good grade with a scraper

Huge 518 hp. scrapers like this often have to maneuver giant loads on hills—up, down and sideways. Engineers who design these mammoth earth movers have to provide for the terrific, combination radial and thrust loads, plus shock loads. To take the loads and assure dependable scraper performance engineers mount wheels, pinions and differentials on Timken® tapered roller bearings.



Tapered design lets Timken® bearings take both radial and thrust loads

Not all bearings can take loads from the sides, as well as from above. The tapered design of Timken bearings lets them take *both* radial and thrust loads in any combination. And because Timken bearings roll the load on a full line of contact between their rollers and races, they have extra load-carrying capacity.

Want to learn more about job opportunities?

Timken bearings help make better machines. And better machines make our lives richer, give us more leisure time. We call it Better-ness. Why not find out more about Better-ness and how you can help create it. Write for: "BETTER-ness and Your Career at the Timken Company". The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ↓ AND THRUST →|← LOADS OR ANY COMBINATION ✳

STRESS *and* STRAIN...

Child specialist giving advice to mother: "You'll have to handle this child carefully: remember you're dealing with a sensitive, high-strung little stinker."

• • •

Advertisement in newspaper: "Millionaire, young, good-looking, wishes to meet, with a view to marriage, a girl like the heroine of M—'s novel." Within 24 hours the novel in question was sold out.

• • •

A "blind" beggar was arrested when a policeman noticed him reading a newspaper. "I wasn't reading," the man pleaded, "I was just looking at the pictures."

• • •

Turning to the best player of their bridge foursome, the novice asked, "Well, how would you have played that last hand of mine?" "Under an assumed name," was the prompt answer.

• • •

Sign in a dance hall: "The Management reserves the right to exclude any lady they think proper."

• • •

A man obviously in bad condition from the night before stepped up to a bar and muttered, "Give—give me something for a hangover."

"What do you want?" asked the bartender.

The sufferer could only blurt: "Tall—cold—and full of gin."

"Sir," snapped a drunk standing next to him, "you are referring to the woman I love."

• • •

One angry skunk to another skunk: "So do you!"

• • •

Recent tests in the physics department prove that grasshoppers hear through their legs. When a tuning fork was placed near a grasshopper, it was found that in all cases the insect would hop. There was no reaction to this stimulus, however when the insects legs were removed.

Following is an excerpt from a letter received in this office some days ago:

Dear Sir:

In the coming months, you'll be reading many job recruiting ads. We thought that you might need some help in wading through this maze of placementology or jobalony. Here are a few between-the-lines daffynitions to help you understand what these ads are all about:

TERM	TRUE MEANING
Many opportunities	We need help.
Management potential	Know how to write your name so that no one can read it.
Work with top engineers	Sign up with a toy factory.
Top-level position	A title in lieu of a raise.
Challenging problems	Now that we've made it, we don't know what to do with it.
Experience	What you ain't got enough of till you're too old to use it.
Responsible assignments	Work.
Nearby beaches	Particularly Utah and Nevada where you have thousands of miles of beach.
Less than an hour from	By jet.
Cultural and entertainment facilities	Movies and bars available.
Job interest	Good looking secretary.
Stimulating assignments	Office party.
Stable company	We lived through the depression.
Full quota of golfing	We're really running a country club; swimming, riding, etc.—manufacturing is just our hobby.

• • •

The gentleman was gazing rapturously at "Spring," a large oil painting of a shapely girl dressed only in a few strategically arranged leaves. Suddenly the voice of his wife snapped, "Well, what are you waiting for—autumn?"

A Cornell engineer was discovered by his wife one night standing over his baby's crib. Silently, she watched him. As he stood looking down at the sleeping infant, she saw in his face a mixture of emotions—rapture, doubt, admiration, despair, ecstacy, incredulity. Touched and wondering alike at this unusual parental attitude and the conflicting emotions, the wife, with eyes glistening, slipped her arms around him.

"A penny for your thoughts," she said in a tremulous voice.

He blurted out, "For the life of me, I can't see how anybody can make a crib like that for three forty-nine."

• • •

A farmer was driving past an insane asylum with a load of fertilizer when an inmate called to him:

"What are you hauling there?"

"Fertilizer," replied the farmer.

"What are you going to do with it?"

"Put it on my strawberries."

"You should live here, we get sugar and cream on ours."

• • •

Sue: "I wonder if Jack loves me?"

Mabel: "Of course he does, dear. Why should he make you an exception?"

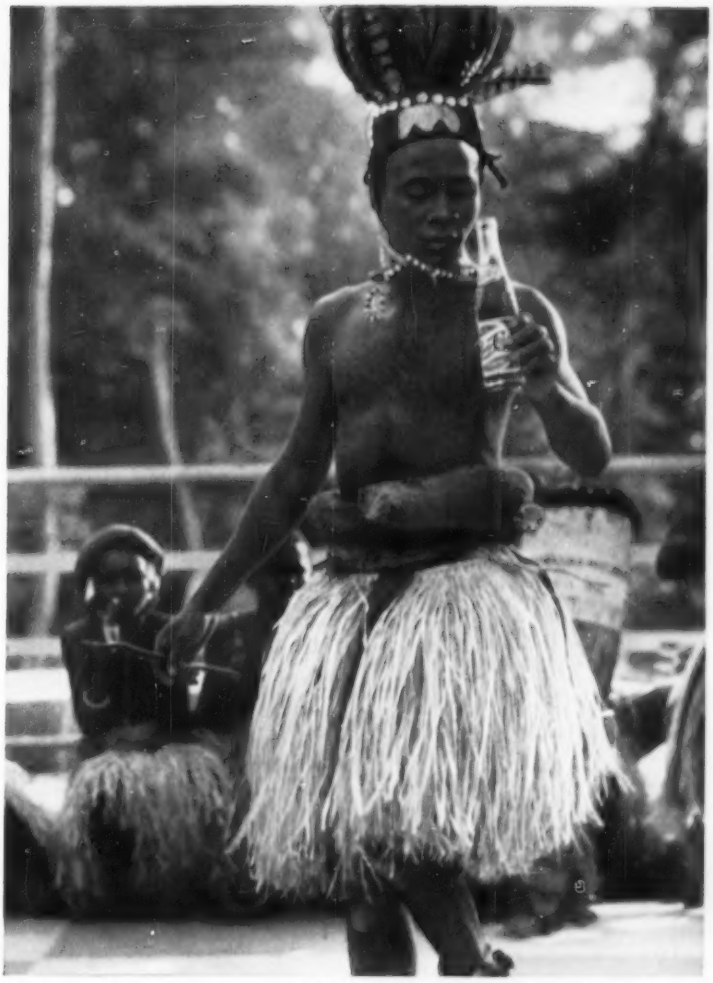
• • •

"I hope I'm dummy on the next hand. I've got an important prelim tomorrow."

PHOTOGRAPHY AT WORK
No. 30 in a Kodak Series

Pepsi-Cola International Panorama, a magazine of places and people, reaches people around the world, builds recognition for Pepsi-Cola as a product associated with the better, happier side of life.

Photography speaks in every language



What better way to say people take naturally to "Pepsi" whether in Leopoldville or Lichtenstein?

This picture leaves no doubt that Netherlanders are neighborly.

To tell its story in 75 countries, Pepsi-Cola puts pictures to work to add meaning to the product's global billing as "the refreshment of friendship."

To build up an atmosphere of friendliness and understanding in markets around the world, Pepsi-Cola International publishes "Panorama"—and gives the brunt of the job to photography.

Photography knows no language barrier. It is clear to young and old alike—appeals to everyone. With photography, people are real; situations authentic, convincing. This is what makes photography such a powerful salesman.

Large businesses and small can use this powerful salesmanship—can also use photography to cut costs and save time in many other ways. It can help with problems of product design—can watch quality in production. It trains. It cuts office routine. You'll find that it can work for you, too.

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

CAREERS WITH KODAK

With photography and photographic processes becoming increasingly important in the business and industry of tomorrow, there are new and challenging opportunities at Kodak in research, engineering, electronics, design and production.

If you are looking for such an interesting opportunity, write for information about careers with Kodak. Address: Business and Technical Personnel Dept., Eastman Kodak Company, Rochester 4, N. Y.

Kodak
TRADE MARK

One of a series*

Interview with General Electric's W. Scott Hill Manager—Engineering Recruiting

Qualities I Look For When Recruiting Engineers

University Microfilms
313 N. First St.
Ann Arbor, Mich.

Q. Mr. Hill, what can I do to get the most out of my job interviews?

A. You know, we have the same question. I would recommend that you have some information on what the company does and why you believe you have a contribution to make. Looking over company information in your placement office is helpful. Have in mind some of the things you would like to ask and try to anticipate questions that may refer to your specific interests.

Q. What information do you try to get during your interviews?

A. This is where we must fill in between the lines of the personnel forms. I try to find out why particular study programs have been followed, in order to learn basic motivations. I also try to find particular abilities in fields of science, or mathematics, or alternatively in the more practical courses, since these might not be apparent from personnel records. Throughout the interview we try to judge clarity of thinking since this also gives us some indication of ability and ultimate progress. One good way to judge a person, I find, is to ask myself: Would he be easy to work with and would I like to have him as my close associate?

Q. What part do first impressions play in your evaluation of people?

A. I think we all form a first impression when we meet anyone. Therefore, if a generally neat appearance is presented, I think it helps. It would indicate that you considered this important to yourself and had some pride in the way the interviewer might size you up.

Q. With only academic training as a background, how long will it be before I'll be handling responsible work?

A. Not long at all. If a man joins a training program, or is placed directly on an operating job, he gets assignments which let him work up to more responsible jobs. We are hiring people with definite consideration for their potential in either technical work or the management field, but their initial jobs will be important and responsible.

Q. How will the fact that I've had to work hard in my engineering studies, with no time for a lot of outside activities, affect my employment possibilities?

A. You're concerned, I'd guess, with all the talk of the quest for "well-rounded men." We do look for this characteristic, but being president of the student council isn't the only indication of this trait. Through talking with your professors, for example, we can determine who takes the active role in group projects and gets along well with other students in the class. This can be equally important in our judgment.

Q. How important are high scholastic grades in your decision to hire a man?

A. At G.E. we must have men who are technically competent. Your grades give us a pretty good indication of this and are also a measure of the way you have applied yourself. When we find someone whose grades are lower than might be expected from his other characteristics, we look into it to find out if there are circumstances which may have contributed.

Q. What consideration do you give work experience gained prior to graduation?

A. Often a man with summer work experience in his chosen academic field has a much better idea of what he wants to do. This helps us decide where he would be most likely to succeed or where he should start his career. Many students have had to work hard during college or summers, to support themselves. These men obviously have a motivating desire to become engineers that we find highly desirable.

Q. Do you feel that a man must know exactly what he wants to do when he is being interviewed?

A. No, I don't. It is helpful if he has thought enough about his interests to be able to discuss some general directions he is considering. For example, he might know whether he wants product engineering work, or the marketing of technical products, or the engineering associated with manufacturing. On G-E training programs, rotating assignments are designed to help men find out more about their true interests before they make their final choice.

Q. How do military commitments affect your recruiting?

A. Many young men today have military commitments when they graduate. We feel it is to their advantage and ours to accept employment after graduation and then fulfill their obligations. *We have a limited number of copies of a Department of Defense booklet describing, in detail, the many ways in which the latter can be done. Just write to Engineering Personnel, Bldg. 36, 5th Floor, General Electric Company, Schenectady 5, N. Y.* 959-8

***LOOK FOR other interviews discussing: • Advancement in Large Companies • Salary • Personal Development.**

GENERAL ELECTRIC